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CONTENTS.

EDITORIALS—
Central Station Rates 369
The Locomotive Smoke Evil and Its Cure.....370
Fire Hazard of Electric Signs.....370
Carbon Tetrachloride 371
Trade Follows the Light 371
The Usefulness and Functions of the Illuminating Engineering Society 371
The Illuminating Engineering Society 372
Program of Minnesota Electrical Association's Convention.....372
Commercial Section of National Electric Light Association Membership Campaign 372
Illinois Electric Railways Association 372
Carbon Tetrachloride 372
A. E. Kennelly 373
Resistance of Wires at High Frequencies 373
Convention of American Institute 373
Locomotive Smoke in Chicago 374
The Telephone Service of Greater New York.....375
Exhibition of Engineering School.....382
Meeting of National Electrical Jobbers' Association.....382
Chicago Section, Illuminating Engineering Society.....383
Directive Wireless Telegraphy 383
Some Geometrical Aspects of the Three-Charge-Rate System—III.—By Hugo E. Eisenmenger.....384
Trolley Freight Service 387
American Institute of Electrical Engineers 388
High-Tension Testing of Insulating Material.....388
Hysteresis and Eddy-Current Exponents for Silicon Steel.....388
Commercial Problems of Transformer Design 388
Design, Construction and Tests of an Artificial Transmission Line..390
Tests of Losses on High-Tension Lines.....390
Mechanical Forces in Magnetic Fields.....391
The Regulation of Distributing Transformers.....391
Temperature Gradient in Oil-Immersed Transformers.....391
Problems in the Operation of Transformers.....392
Elements of Power-Station Design—XXIV—By W. B. Gump.....339
The Flame Arc Holds the Trade—By H. Thurston Owens.....396
Lighting and Heating Plant of the Department of the Interior.....397
World's Production of Tungsten 397
Inspection of Telephone Wire—By Hugh T. Wreaks.....398
Mackay Company's Extensions 400
Motor Drive in Plant of Willys-Overland Company—By W. A. Hill....401
Central Station Working with Contractors.....403
FINANCIAL REPORTS OF ELECTRICAL COMPANIES.....404
NEW ELECTRICAL AND MECHANICAL APPARATUS AND APPLIANCES.....405
CURRENT ELECTRICAL NEWS 409
PUBLIC SERVICE COMMISSION NEWS.....409
RECORD OF ELECTRICAL PATENTS.....414

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CENTRAL-STATION RATES.

The great disadvantages which accrue from a system of rates which does not comprise elements corresponding to all the elements of expense is made very manifest by the discussion of this subject by Mr. Hugo E. Eisenmenger, the concluding portion of whose article will be found in this issue. Dividing the total expenses up into three parts, depending respectively upon the energy consumption, the maximum demand and the number of receiving circuits, he shows by a geometrical analysis that any departure from the "real" point of rates (determined by the above three elements of expenses) encourages unprofitable customers at the same time that it discriminates unjustly against certain classes of profitable customers. It is practically impossible to determine this real point of rates, and the point probably changes from month to month for any actual case, but it is unnecessary to know the exact location of this point in order to study the effect which departures from it will have upon the customer and upon the central station.

Whether it is advisable or commercially expedient to fix rates in accordance with this "real" point of rates is very doubtful, as the author admits, since small departures from it in a proper direction may help to build up a business. Exact justice may then not be dispensed to every customer, but the result in the long run may be the lowering of rates to all customers. It may consequently be justifiable.

We are so accustomed to a straight meter rate, and in other transactions to payment according to the quantity of a commodity received, regardless of the expense of delivery, that few of us realize how illogical and discriminatory it is. Indeed, when attempts are made to overcome its defects by special contracts or sliding scales, we are likely to think that discrimination is being made on the other side. A close study of the question, however, makes it apparent how clumsy, illogical and unfair a straight meter rate is — fully as much so as a flat customer rate, or a flat rate based on connected load. A recognition of this has brought the sliding scale and its close neighbor, the system of discounts, as well as the minimum charge supplementary to a meter rate.

It seems rather curious at first sight that while the central stations have been awakening to the inadequacy of a

meter rate, and are manipulating it so as to partly cover other elements of expense, the telephone companies are abandoning the flat customer charge, and substituting for it rates based upon metered service. But both evolutions result from the same fundamental idea—a recognition that no rate based upon a single element of expense can be either fair or entirely adequate. And it is also true that no such rate can attract all the business which a just distribution of expenses will call into existence. A rate which recognizes all the elements of expense will result in the fullest development of profitable business.

With the wider extension of governmental regulation of the rates of public-service corporations, the abandonment of the special contract as a means of adjustment to the conditions of service to different customers seems inevitable. A sliding scale with a minimum charge may to a certain extent meet the necessities of the case, but it would seem that a three-charge rate gives the greatest promise of satisfaction from every point of view, even though it is practically impossible to approximate very closely to the "real" point of rates. In considering the element of maximum demand, it should be borne in mind that it is the maximum demand at the time of peak load which is the important factor, and that any reasonable demand at other times involves no "demand" expense to the central station. For this reason it is insufficient to substitute connected load for maximum demand, in considering this element, even on a system with a purely lighting load. In recognition of this fact, extremely low meter rates can be made to off-peak customers, as is regularly and systematically done by certain central stations.

Henry L. Doherty, on the occasion of the Convention of the National Electric Light Association in Chicago, in 1900, gave to the central station industry a comprehensive analysis of the components entering into the making of a system of charging for electrical energy. Mr. Doherty's ideas were opposed by some of the leaders in the industry at that time. This discussion of the problem has been logically carried forward. In this progressive movement none is entitled to greater credit than Samuel Everett Doane, through whom much of the material used in the preparation of the article under discussion has been made available.

THE LOCOMOTIVE SMOKE EVIL AND ITS CURE.

A forcible argument for the electrification of railroad terminals was presented in a paper read by Mr. Paul P. Bird, chief smoke inspector of the City of Chicago, before the Western Society of Engineers last week. An abstract of this paper appears in another part of this issue, so it will suffice here merely to comment on some features of it.

Chicago is the largest railroad center in the world. Within its borders are about 2,200 miles of railroad track operated by twenty-three trunk lines and twelve belt or transfer railroads. On these tracks there are at all times an average of about 1,400 steam locomotives burning almost exclusively the cheap soft coal from the Illinois coal fields. The traffic has steadily increased and with it the nuisances attendant on the use of steam locomotives. As a result there has arisen a strong public demand for the suppression of the smoke evil. Despite its limited inspection force, the City's smoke department has done much to abate the nuisance, both by prosecuting chronic offenders and by suggesting improvements in furnace construction and in firing methods. After several years of work along these lines, the general public feeling has still been that the railroad locomotives were the most pronounced smoke producers. The extended investigations undertaken last fall under Mr. Bird's direction have strikingly verified this.

Coming from a public official and an expert on smokeless combustion, Mr. Bird's finding that electrification offers the only final and satisfactory solution of the locomotive smoke problem, brings great weight to a demand that was accused of being merely sentimental. When it is considered that electrification will solve also the cinder, dirt and noise problems of railroad operation in a large and congested city and produce increased traffic capacity and decreased operating cost, it is strange that the railroads have failed to take up active planning of electric service, but have allowed the matter to drift to the point where the authorities are about to pass a mandatory ordinance to compel terminal electrification.

FIRE HAZARD OF ELECTRIC SIGNS.

In erecting electric signs upon or adjacent to buildings, care should be taken to see that no woodwork or other inflammable material is sufficiently near to the lamps to be unduly heated. Neglect of this simple precaution will largely increase the risk of fire from this source. Careful attention should also be given to the proper support of large signs, especially where these are exposed to the wind, and it should also be seen to that in case the sign should by any means become loosened it would not fall upon the street or upon adjacent buildings. Such a contingency may easily arise from fire originated by other sources. Switches should be placed in accessible positions so that power may be cut off whenever desired, not only by those in charge of the sign, but by firemen or others who may have occasion to go upon the roof.

The necessity for careful attention to these matters by those responsible for the construction and those interested commercially in electric signs is made all the more urgent in view of the campaign which is under way among the fire underwriters to limit or possibly suppress the use of electric signs for advertising purposes. In combating this movement the position of sign users should be impregnable and this will only be the case if they give proper regard to those considerations which to the fire insurance companies and to the city fire departments seem important.

CARBON TETRACHLORIDE.

The damage caused by fires is so often greatly increased by the water used to extinguish the fire, that it has become a matter of general comment and popular knowledge. Indeed the damage by water often exceeds the damage by fire. Where electrical equipment is involved, the danger from water is especially marked, since the deterioration of insulation is almost sure to follow any contact with water, unless impervious materials have been used. Even when the material can be dried out and thus restored to its original condition, much trouble, delay and expense are often involved.

The use of sand and of vapor extinguishers has consequently displaced the use of water in many places, and no telephone switchboard, for instance, is considered to be properly protected unless a box of sand is available behind the switchboard. Owing to the compactness of the installation and the difficulty of removing it, this illustration presents a case where it is almost impossible to eliminate the effects of water without completely tearing out the board. Even sand, however, has its disadvantages, and although a blast of vapor leaves no bad effects, it is perhaps not so easily handled as liquid. An ideal fire extinguisher would seem to be a non-conducting, non-inflammable and volatile liquid, which would not attack metal or insulation and leave no after-effects.

Such a liquid seems to have been found in carbon tetrachloride, which is now commercially available at a reasonable price. It should prove a boon in telephone exchanges, power-houses and similar installations.

A short article to be found upon the next page gives a few of the properties of this most interesting chemical compound. It is highly probable that there are other organic compounds which would have the necessary properties, and we may some day find them.

TRADE FOLLOWS THE LIGHT.

Trade may or may not follow the flag, but trade follows the light, and, what is still more important, light holds the trade. Both of these facts are forcibly brought out in the article by Mr. H. Thurston Owens on "The Flame Arc Holds the Trade" in this issue.

The title which Broadway has acquired "The Great White Way" would lead many to suppose that it is a much overlighted thoroughfare, and yet we find that within a short time no less than sixteen 3,000-candlepower flame arcs have been installed upon a stretch of 200 feet! And further that the store lighting and sign lighting have been increased!

This installation was made to hold the trade, while the others were made to obtain it. In every case the signs have been included and those who cavil against this new weapon upon the score of decreased use of light for window and sign lighting must indeed be pessimists.

THE USEFULNESS AND FUNCTIONS OF THE ILLUMINATING ENGINEERING SOCIETY.

The address of Dr. Herbert E. Ives, vice-president of the Illuminating Engineering Society, before the Chicago Section last week, discussed the subject of the relations which the Society should have with other bodies and with the general public.

It is very generally admitted that the knowledge of the general public in regard to illuminating engineering is woefully lacking, and outside of the benefit of the Society to its own members it can fill no better purpose than by attempting to educate the public in the proper use of sources of illumination. As pointed out by Dr. Ives, this can be done by co-operating with educators, opthalmologists and others, but more especially can this result be achieved by getting in close touch with those who have largely the responsibility for determining the kind of installation which is put in for illuminating purposes.

It is well known that the illuminating engineer is called in only in the case of large projects and a great deal of the advice which comes to the user of light upon a small scale is from the contractor who puts in the installation or from the man who sells either the fixtures or the illuminant. In the case of electric lighting the latter is the central-station man and he is the one upon whom perhaps the Society could exert the greatest influence in bringing about proper conceptions of the use and abuse of electric light.

To reach the central-station man should not be a difficult matter. In most of our states they are banded together either in a state organization or as a geographical section of the National Electric Light Association. The Illuminating Engineering Society should undertake a campaign to see that no state convention of central-station men passes by without one or more papers dealing with the subject of proper illumination and the means available to secure it. Work of this kind would no doubt tend to spread correct ideas on this subject more rapidly and effectively than could the same amount of energy expended in any other way. The attitude of the central-station man in his community will affect more installations than any one other thing, and if he has the proper ideas on the subject he will prove a valuable disciple in spreading the doctrine for which the Society should stand. Some progress has already been made in this line, for the programs of some of these meetings have papers on this subject in evidence, but in others, and more especially the smaller ones, much yet remains to be done.

Meetings of electrical contractors should receive like attention, and if possible the manufacturers of both gas and electric fixtures should be reached. Attempts to co-operate with the architects have perhaps not proved encouraging to any broader efforts, but it is quite possible that the architect has found the matter too one-sided. In his case there is opportunity for both give and take.

THE ILLUMINATING ENGINEERING SOCIETY.

ADDRESS BEFORE CHICAGO ELECTRIC CLUB.

A brief resúmé of the history, activities and benefits of the Illuminating Engineering Society was given in an address before the Chicago Electric Club on February 15 by Frederick J. Pearson, chairman Chicago Section, Illuminating Engineering Society.

The origin of the society dates back to 1905 when a number of engineers conceived the idea of forming an association having for its object the advancement of the science of illuminating engineering. Early in 1906 the society was organized with a charter membership of fifty-six. Today there are over 1,500 members.

The membership of the society is a cosmopolitan one, there being men representing practically every phase of engineering. Of the entire membership 60 per cent are men identified with electrical interests, 20 per cent with gas companies and 20 per cent miscellaneous branches of engineering.

George C. Keech opened the discussion by referring to the successful convention and lecture course held by the society last fall in Baltimore.

James R. Cravath referred to the origin of the term "illuminating engineer," which he believes was first used generally in 1902.

F. H. Bernhard called attention to the meetings of the Chicago Section, outlining the program of procedure at these meetings and inviting the members of Electric Club to attend.

G. H. Stickney spoke briefly on the value of illuminating engineering.

F. P. Vose spoke of the attitude of the achitects and electrical contractors, citing a case where the terms of the specifications of the former exacted unreasonable requirements from the contractors. He urged that the Electric Club use its influence in remedying these conditions.

Secretary Obright then read the list of appointments to the Speakers' Committee as follows: C. A. Howe, chairman; A. A. Gray, N. B. Parsons, J. R. Cravath, J. H. Delany, F. F. Fowle, G. C. Keech, H. F. Holland, R. H. Rice, F. P. Vose, F. L. Perry, G. H. Lukes, R. S. Mitten, E. H. Noyes and Edward Wray.

Program of Minnesota Electrical Association's Convention.

As previously announced the fourth annual convention of the Minnesota Electrical Association will be held in St. Paul, Minn., March 14, 15 and 16, 1911. Headquarters will be established at the new St. Paul Hotel, the meetings being held in the Sun Parlor.

Owing to an amendment of the by-laws of the Association admitting central-station men from North and South Dakota to membership, a large attendance is anticipated.

The following list of papers to be presented at the convention has been announced:

"Curb Lighting," by Ludwig Kemper, Albert Lea Light & Power Company; "Window and Sign Lighting," by George Steinwedell, St. Paul Gas Light Company; "Residence Lighting," by C. E. Van Bergen, Duluth Edison Company; "Sales Department for Cities, Up to 5,000," by Herbert Markle, Consumers Power Company, Stillwater; "Gas Producer Engines for Central Stations," by A. W. Wagner, Huron Light & Power Company; "Gasoline Competition," by a representative of the National Electric Lamp Association; "Testing Watt Meters," by F. R. Cutcheon, St. Paul Gas Light Company; "Engine and Boiler Room Records for Plants Up to 256 Kilowatts," by E. Holcombe, Northern Heating & Electric Company; "Insurance," by Mr. Ritt, St. Paul Bureau of Underwriters; "Day Load for Central Stations," by E. L. Callahan, H. M. Byllesby & Company; "Incandescent Lamp Improvements," by Henry Schroeder, General Electric Company, and "Safety in Line Construction," by H. G. Winsor, Minneapolis General Electric Company.

Commercial Section of N. E. L. A. Membership Campaign.

A beautiful sterling silver loving cup, ten inches in height, has been donated by J. Robert Crouse for presentation to the individual who shall succeed in securing the greatest number of new members for the Commercial Section of the National Electric Light Association before May 15, 1911. Mr. Crouse is chairman of the Membership Committee, and its other members are Edward E. Bailey, Napoleon H. Boynton, Charles D. Burleigh, Duncan Campbell, W. R. Collier, I. W. Dixon, I. D. Gibbs, L. D. Mathes and J. C. McQuiston.

Large posters, embellished with a full-sized reproduction of the cup, and giving the conditions of the contest will be sent to the principal central stations and electrical manufacturers of the country, and the committees hope that these posters will stimulate immediate interest in membership among the employes who will read them.

Illinois Electric Railways Association.

The organization meeting of the Illinois Electric Railways Association was held on February 17 at the Great Northern Hotel, Chicago, and it was at that time decided to make the organization a permanent one.

Regular meetings will be held on the third Friday of each January, March, May, September and November, and an attempt will be made to divide the places of meeting between the different cities represented in the Association.

Carbon Tetrachloride.

The development of the electrolytic cells for the production of chlorine and caustic soda, with the consequent cheapening of chlorine gas, has cheapened the process of producing carbon tetrachloride. Coincident with this, the process of manufacturing carbon-bisulphides has been improved and cheapened. Chlorine gas is passed over heated carbon-bisulphide and the products condensed in a cooler. A mixture of carbon tetrachloride and sulphur dichloride is obtained and by introducing caustic soda or potash into the mixture the sulphur dichloride is decomposed and dissolved, the carbon tetrachloride separating and falling to the bottom of receptacle, being afterwards purified by distillation.

Carbon tetrachloride is sold in 100-gallon drums and smaller lots in containers. It is sold by weight, there being thirteen and one-half pounds per gallon. Present quotations are about ten cents per pound in drums.

Carbon tetrachloride is a clear, colorless volatile liquid with an agreeable aromatic odor. Specific gravity 1.604 and boiling point 78 degrees centigrade. It is non-inflammable and non-explosive and its vapors extinguish fire.—*Quarterly of the National Fire Protection Association.*

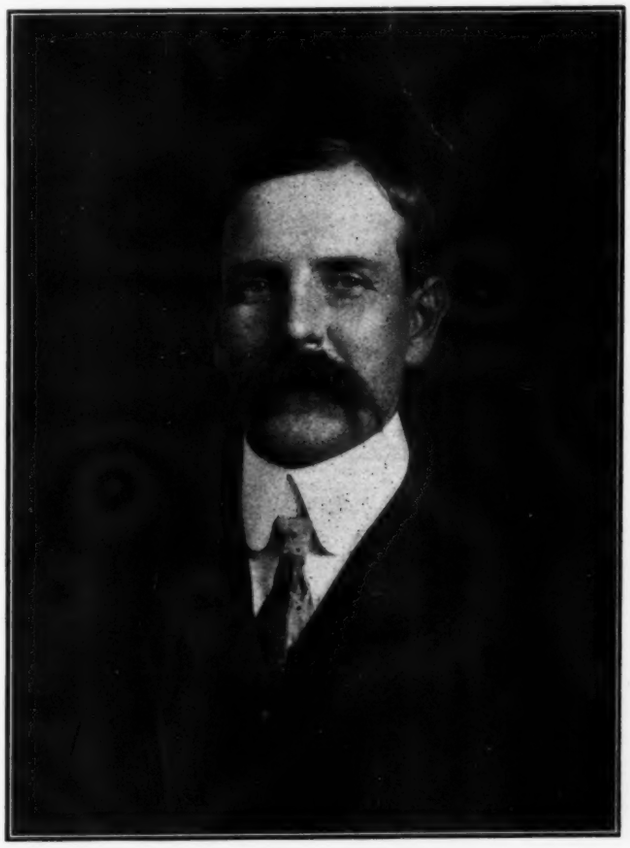
A. E. Kennelly.

Arthur Edwin Kennelly, engineer, instructor and litterateur, has had a most interesting and varied career. Associated in the early days with some of the most important telegraph and cable developments, born and educated abroad, he has achieved distinction in this country such as few men have aspired to.

Professor Kennelly was born in Colaba, Bombay, India, December 17, 1861, the son of Captain David Joseph and Catherine (Heycock) Kennelly. He was educated in the private schools of England and Scotland and in the University College School at London. He received the honorary degree of Doctor of Science from Western University in Pennsylvania in 1895, and the degree of Master of Arts from Harvard in 1906.

Professor Kennelly was a telegraph operator in England in 1876, and assistant electrician in Malta in 1878. In 1881 he was chief electrician of a cable-repairing steamship and in 1886 was senior ship's electrician for the Eastern Telegraph & Cable Company.

Coming to this country, he was principal electrical assistant to Thomas A. Edison from 1887 to 1894. Later he was associated with Edwin J. Houston in the firm of Houston & Kennelly, consulting engineers, in Philadelphia, 1894 to 1901. Since 1902 he has been professor of electrical engineering at Harvard University.



ARTHUR E. KENNELLY,
President of the Illuminating Engineering Society.

He was engineer in charge of laying the Vera Cruz Frontera-Campeche cables for the Mexican Government in 1903. He has long been a prominent and esteemed member of the American Institute of Electrical Engineers, and was president, 1898-1900. He was president of the Society for Promotion of the Metric System of Weights and Measures in 1904. He is an honorary fellow of the New York Electrical Society, of the American Electrotherapeutic Association, a Fellow of the Royal Astronomical Society, a member of the Institution of Electrical Engineers of Great Britain, a Fellow of the American Academy of Arts and Sciences, a member of the American Philosophical Society, the American Physical Society, the Mathematical Society and the Franklin Institute. He was United States Delegate to the International Electrical Congresses of Paris in 1900, and St. Louis in 1904, and he was general secretary of the latter. He was an electrical juror of the Electrical Exposition of Philadelphia, 1898; Buffalo, 1901, and St. Louis, 1904. He is president of the United States committee of the International Electrotechnical Commission. He was elected president of the Illuminating Engineering Society for the present year.

He is author of Electrical Notes for Electrical Students, with Wilkinson, 1890; Theoretical Elements of Electrodynamic Machinery, 1893; with Edwin J. Houston he is the author of Electrical Engineering Leaflets, 1897; Elementary Electrotechnical Series, 1897; Electrodynamic Machinery, 1898; Recent Types of Dynamo-electric Machinery, 1899; Electricity Made Easy, 1899; The Interpretation of Mathematical Formulas, 1899; Wireless Telegraphy, 1907. He has been a frequent contributor to the scientific press and is the author of many papers read before the various national engineering and scientific societies. His studies upon the mathematical analysis of various problems in design, construction and transmission have added greatly to the literature on this subject, and his discussions have been widely published in all parts of the world.

He was married on July 22, 1904, to Julia Grice, of Philadelphia, and is a resident of Cambridge, Mass.

Resistance of Wires at High Frequencies.

In a paper read before the Physical Society of London, J. A. Fleming presented some experimental measurements of the resistance of wires for high-frequency currents. A differential air thermometer was used to compare the heating effects in two wires to be compared, and the resistances thus obtained in terms of the currents used. The high-frequency currents were obtained by means of condenser discharges, and a continuous current used for comparison, in a differential thermometer containing two equal wires.

The experimental results compare well with calculated values based on well-known formulas, the correction for damped oscillations being less than one per cent. The resistance of a spiral is greater than that of the same wire when straight by as much as eighty per cent.

With wires made of magnetic metals the resistance is greater and it is shown that the measurements serve to determine the permeability of the metal for small magnetizing forces of high frequency.

Convention of American Institute.

It has been announced that the next convention of the American Institute of Electrical Engineers will be held in June this year in or near Chicago.

LOCOMOTIVE SMOKE IN CHICAGO

DISCUSSION BEFORE WESTERN SOCIETY OF ENGINEERS.

At a meeting of the Western Society of Engineers, held at the Society rooms in the Monadnock Block, Chicago, on the evening of February 15, Paul P. Bird, chief smoke inspector of the City of Chicago, presented a paper entitled "Locomotive Smoke in Chicago."

Mr. Bird's paper recites at some length the investigations that were made relative to the character and amount of smoke poured from the steam-railroad locomotives within the city. Chicago is the greatest railroad center and one of the largest manufacturing centers in the world. In the agitation for the electrification of railroads in Chicago, it has generally been stated that they were doubtless the worst offenders in the city as regards the smoke nuisance. They have, however, asserted that the conditions do not at all warrant such broad statements. The investigation was therefore undertaken to verify the general public opinion, which it strikingly does.

In order to arrive at a proper means of determining the amount of locomotive smoke and its relation to the total smoke produced, it was first necessary to make a careful series of tests of the density of such smoke, which was done by the Ringlemann chart method. It was found that this method was just as reliable for determining the density of locomotive smoke as it is for determining that from stationary plants. Over 11,000 separate observations were made in various parts of the city. Similar tests were made of the smoke output of stationary plants, office buildings, flat buildings, residences, steam boats and special furnaces, such as steel mills, foundries, etc. The makers of smoke were divided into seven classes and a careful estimate made of the amount of coal consumed by each per day. By relating the density of the smoke with the number of chimneys and the amount of coal used in each class, the relative amounts of smoke produced by these different classes were ascertained. The results are given in the following table:

Class of Consumers.	Annual Coal Consumption. Tons.	Per Cent.	Smoke. Per Cent Density.	Per Cent of Total.
Central District	1,500,000	15.	3.75	6
Miscellaneous Power Plants	4,500,000	45.	6.5	30
Flats	750,000	7.5	3.0	2½
Domestic	650,000	6.5	3.0	2
Special Furnaces	600,000	6.	20.0	12½
Railroads	1,850,000	18.5	22.3	43
Boats	150,000	1.5	25.0	4
Total	10,000,000	100.		100.

Tests were also made of the smoke production from steam locomotives in cities and towns adjoining Chicago, to determine whether the density of the smoke was greater within than it was without the city limits. A careful estimate was made of the great amount of sparks, soot and cinders thrown out by locomotive smokestacks.

The author of the paper states that in his opinion it is economically impossible for the steam railroads to use other than a low grade of cheap coal, such as the common Illinois or Indiana coals. Other fuels, such as semibituminous coal and coke have been tried, but while reducing the smoke somewhat they have by no means decreased the amount of soot and cinders blown from the stacks. At the same time the cost of fuel becomes almost prohibitive. Moreover, without careful attention even a high-grade fuel is by no means smokeless. The author concludes, therefore, that in his opinion electrification offers the only final and satisfactory solution of the locomotive smoke problem. The use of special fuel for preventing smoke on steam locomotives is only a makeshift and will not satisfy the public. The author's other conclusions respecting the investigation are as follows:

(1) Although the locomotives of the city use only eighteen and one-half per cent of the total coal, they make forty-three per cent of the total smoke and over one-half of the total dirt.

(2) The locomotives consume within the city limits 5,600 tons of soft coal daily, or about 1,850,000 tons annually.

(3) According to the Ringlemann system of judging the density or blackness of smoke, the average density of locomotive smoke in Chicago is twenty-three per cent.

(4) Railroad locomotives make forty-three per cent of all the smoke made in Chicago.

(5) Because smoke from locomotives carries with it large quantities of sparks and cinders, such smoke is a greater dirt producer than smoke from stationary plants.

(6) Although locomotives make forty-three per cent of the total smoke, because of the character of the smoke they produce over one-half of the total dirt traceable to smoke.

(7) The lowest average density of smoke produced by any one railroad is about ten per cent. This figure probably represents as low an average as can be maintained with steam locomotives, using soft coal.

(8) If all locomotives in Chicago maintained an average smoke density as low as ten per cent the locomotive smoke would still form twenty-nine per cent of the total smoke and probably produce over one-third of the dirt.

(9) Locomotives in the neighboring towns outside of Chicago make an average smoke density of about forty-one per cent, showing that the anti-smoke campaign in the city has already reduced the smoke nearly one-half.

(10) Approximately ten per cent of all coal fired in a locomotive firebox is discharged from the stack in the form of cinders. Within the city limits of Chicago about 560 tons (fourteen carloads) of cinders from locomotive smokestacks are dropped every day.

(11) There are about 2,200 miles of railway track in the city limits. At all times there are about 1,400 different locomotives working in the city, and during a week as many as 3,740 different locomotives are in Chicago.

H. T. Bentley, of the Chicago & Northwestern Raiway, said that great strides had been made in reducing locomotive smoke within the last three or four years. The city's smoke department had made many valuable suggestions which, on being put into effect, have diminished the evil. He thought that, if the volume of the smoke from different sized stacks were taken into account, locomotive smoke would not show such a high percentage.

C. A. Seley, of the Chicago, Rock Island & Pacific Railroad, objected to the findings because the data were based almost entirely on estimates and the observations were unreliable. Electrification is not a panacea for the smoke evil; if carried out, its heavy cost would ultimately have to be borne by the shippers and railroad patrons of the city. He cited at length from the recent Boston Commission ruling. He also contended that Chicago is not an unhealthy city as attested by its low death rate.

J. F. DeVoy, of the Chicago, Milwaukee & St. Paul Railway, grew eloquent in defending the railroads against the charges in Mr. Bird's paper. He thought the paper was worthless. Speaking of electrification he called it impracticable, prohibitory in cost and calamitous in the accidents it would produce. An indication of the far-fetched character of most of his arguments was his statement that "it would even bankrupt God Almighty to carry out such an electrification scheme."

A. Bement declared there are undoubtedly great possibilities of obtaining practically as smokeless combustion on locomotives as in stationary plants. The Chicago smoke department is the best in the country.

Dr. W. A. Evans, health commissioner of the city, said that health is a most important economic factor. A great measure of the success of American engineers at Panama is due to taking proper account of this factor. To base any arguments on the gross mortality statistics is unreliable, however. In the same way other arguments of the railroads can be picked to pieces.

H. H. Evans stated that the published statistics of electrified railroads in this country and abroad do not show any increase of accidents from the use of electric power.

Among others who discussed the subject briefly were Wm. B. Jackson, Paul M. Chamberlain R. H. Kuss, A. Scheible and President O. P. Chamberlain. Mr. Bird closed the discussion by giving Prof. W. F. M. Goss of the University of Illinois as the authority for his figure of ten per cent of the coal fired as being thrown from the stack. He was surprised at the closeness with which various of his inspectors agreed in judging smoke by the Ringlemann method. The investigations, while largely based on the estimates of the railroads themselves and not intended to be more than approximate in character, were nevertheless eminently fair to all interests and gave a good idea of the situation.

The Telephone System of Greater New York.

Description of the Largest Telephone Plant in the World.

Among the great cities of the world, New York City stands high, and one of the most important factors in its growth and prosperity is the efficient telephone service given to its public.

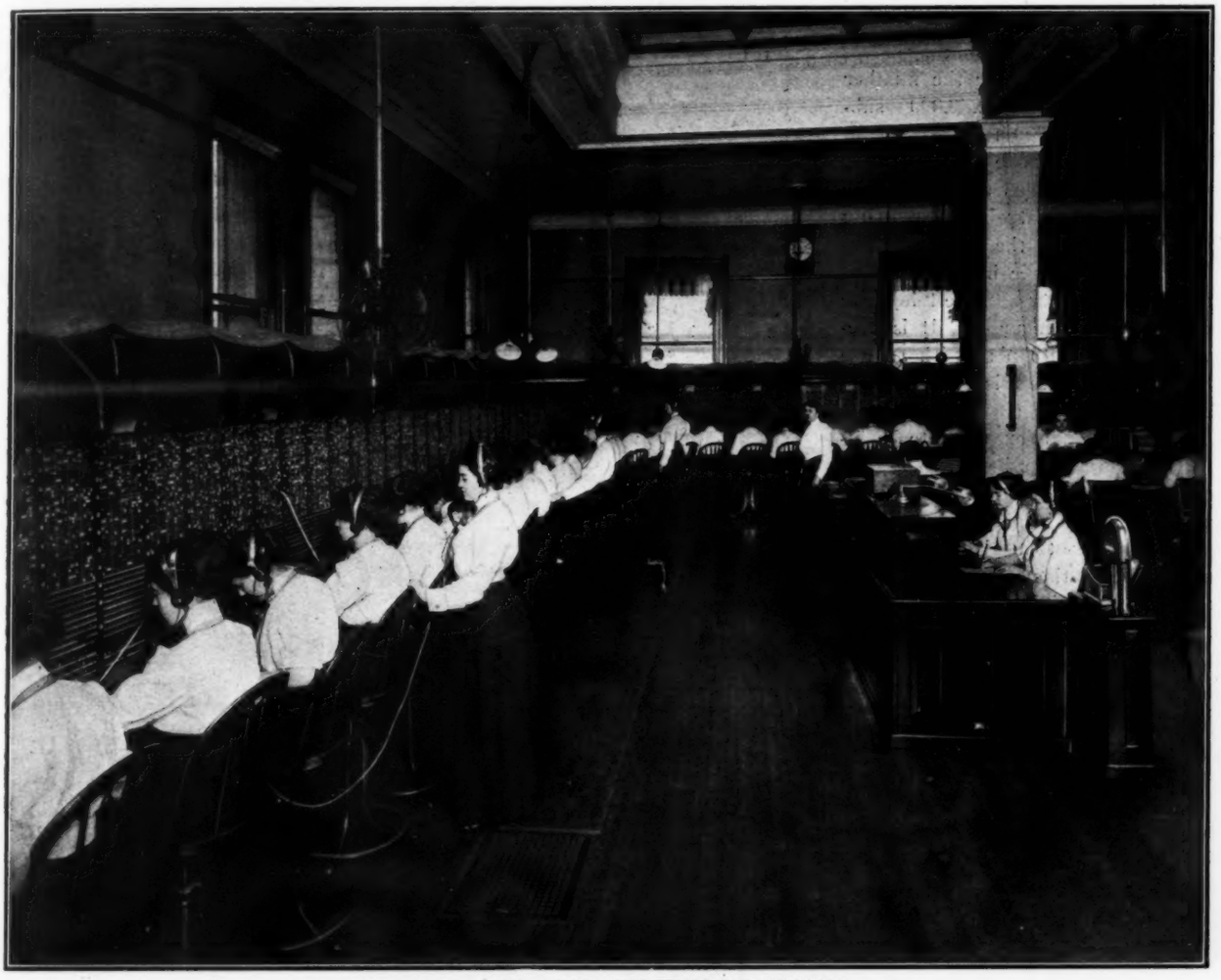
In an address delivered November 15, 1910, President U. N. Bethell, of the New York Telephone Company, gave the following striking figures of the growth of the telephone service of the company as a whole, and in Greater New York.

The assets of the company comprise 182 million dollars in plant alone; 21 million in real estate; 86.5 million in exchange lines; 21.5 million in toll lines; 47.5 million in equipment. and 5.5 million in other plants.

During the first nine months of 1910 the operations of the company have been on a scale that has produced about forty million dollars in gross earnings. The system is about one-third of the entire Bell system in the United States, with approximately one-fourth of the substations and a little less than one-third of the employees, and producing one-third of the gross and net revenue.

New York City has about 400,000 telephones as compared with 365,000 in the rest of New York State. It is the best telephoned big city on the globe, for with a population one-third less than London, it has more than twice as many telephones.

The first public telephone system in New York was started in 1878 and represented an investment of about $20,000. Today, after a lapse of about thirty-three years, the New York Telephone Company represents a *bona fide* investment of over $200,000,000. This capitalization represents the telephone service of the entire state, the State of New Jersey, a small portion of Western Connecticut, together with the control of the Bell Telephone Company of Pennsylvania.



INTERIOR OF A NEW YORK TELEPHONE EXCHANGE.

ORGANIZATION.

The New York Telephone Company aims at the highest standard of service possible, and its management has been developed until it is now looked upon as a universal model. The president of the company is its chief executive. The first vice-president

and general manager is responsible for the entire working, and under him are the engineering, plant, commercial and operating departments.

The total number of employees of the company reaches about 23,000.

EXPANSION.

The introduction of the message-rate or measured-service system has had a profound effect upon telephone traffic and public convenience in Greater New York. This system was inaugurated in 1896 with the result that in three years the number of subscribers was doubled. By 1900, the number was further increased to 56,000; by 1905, to 190,000, and this year the number stands approximately 200,000 subscribers, with 403,609 telephones.

Unless the telephone plant is so planned that additions can readily be made without disturbing existing plant, not only will the service be impaired and the public inconvenienced, but great money losses to the telephone company will be incurred. It is necessary, therefore, to plan with an eye to the future, and to this end a general scheme is made up showing the telephone plant as it is expected to be fifteen or twenty years hence. To make up this scheme, estimates are made of the number and location of subscribers to whom must be given service in the future, and then the most economical method of giving them service is worked out. The telephone company thus has what might be called a scheme of the ideal telephone system of the future, and as plant is needed it is laid out as a part of this general ideal plan. In this way, additions can readily be made and rearrangements of existing plant required by these additions are reduced to a minimum.

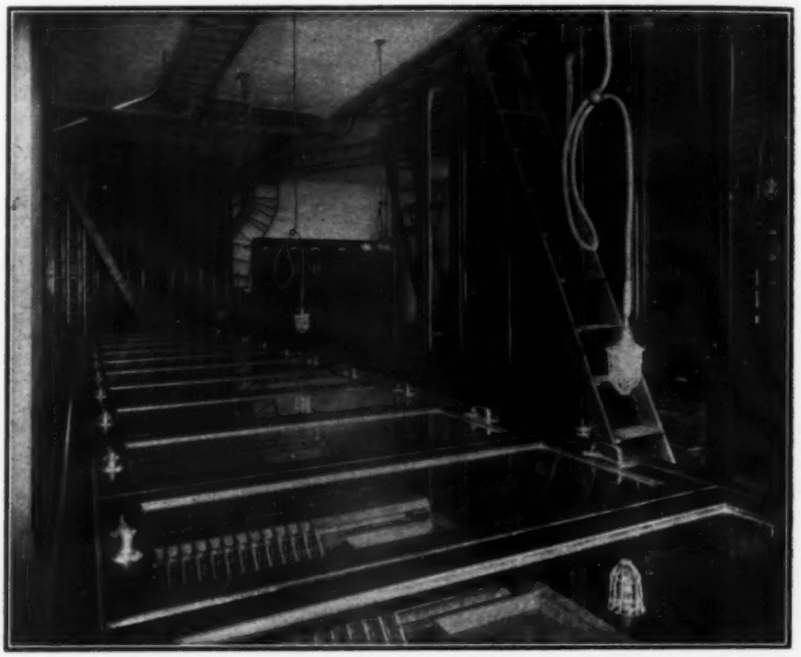
The present plans provide for 690,000 telephones in 1915; 1,090,000 telephones in 1920, and 2,150,000 telephones in 1930 in Greater New York, to serve a population in the last mentioned year estimated at nearly 9,000,000 people.

In order that there may be the necessary switchboard and wire plant immediately available for the connection of new subscribers there must always be spare equipment. It is necessary, therefore, to keep exact records of the spare switchboard and wire plant and to make careful estimates of the expected growth in subscribers for the next year or two, so that additional facilities may be available as soon as required.

EQUIPMENT.

The New York Telephone Company owns all of the buildings in Greater New York that it occupies, except three or four in the outlying sections. The buildings owned by the company are fireproof, constructed according to the best known specifications for fireproof buildings.

In the five boroughs of New York City there are fifty-six central exchanges, all but one of which are equipped or will be equipped this year.



TYPICAL ARRANGEMENT OF STORAGE BATTERIES AND DISTRIBUTING FRAMES.

with the common-battery switchboard.

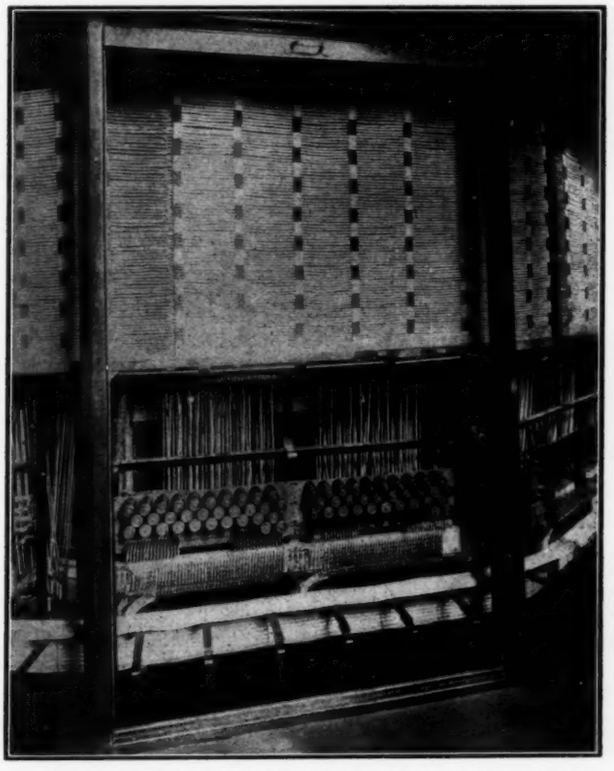
The subscribers' lines leading from the incoming cables end in the main distributing frame, and on the end of each pair is placed a carbon plate and heat coil to protect the switchboard apparatus from foreign currents. The

TYPICAL MAIN DISTRIBUTING BOARD AND ARRESTERS.

wires are carried from the main distributing frame to the intermediate distributing frame in standard switchboard cables. The flexibility of cross connections, attainable by the use of the intermediate frame, permits the equalizing of the operators' load by redistributions of subscribers' lines among the different operators' positions in accordance with growth of service, changes in character of traffic and other variations incidental to the shifting telephone traffic conditions.

The operation of the common-battery multiple switchboard is so familiar as to require only brief mention. The switchboard equipment at each operator's position consists of a number of answering jacks forming the terminals of subscribers' lines, mounted in the lower part of the switchboard panel, and of a number of jacks terminating trunks to other exchanges, and a complete keyboard equipment and operator's telephone; and the operator has access to the lines of all the subscribers in the exchange, which are brought

OPERATOR'S POSITION.



REAR VIEW OF A SECTION OF "B" SWITCHBOARD, SPRING EXCHANGE.

TYPICAL BRANCH-EXCHANGE SWITCHBOARD.

INTERIOR OF COURTLAND-DEY STREET PUBLIC PAY STATION.

out at the calling jacks, multipled at each section of the board. Lamp signals operated by the hook switches of substation instruments (telephone sets) are used for signalling the operators. When a subscriber lifts his hand telephone off its hook, the lamp beneath his answering jack lights up. Plugging in to answer and take the subscriber's call extinguishes this lamp and simultaneously lights up one of the two supervisory lamps on the pair of cords. The operator makes the busy test with the other plug of the pair of cords, and if the called line is clear, plugs in and rings. When the called subscriber answers, a lift of his telephone off its hook puts out the supervisory lamp which was lighted. The two supervisory lamps remain out as long as the connected parties are talking and their lighting-up signals the operator to take down the connection.

The first common-battery switchboards in New York City were installed in 1898, and the last large exchange in Manhattan was changed over about seven years ago. The general introduction of the common-battery system, requiring as it did the construction of new boards to take over the existing traffic and provide for future growth, forced the entire reconstruction of the central-office plant.

In providing new plant the telephone company is guided by the following fundamental principles: (1) The new plant must be of sufficient size to last several years so that it will not be necessary to keep making additions, as this is not only expensive, but interferes with the service. (2) The addition must not be so large that the annual charges of the idle equipment will more than offset the disadvantages of making more frequent additions, and must not be planned for so long a time that errors in the estimate of business to be handled would involve losses.

These principles are well illustrated in building construction. When land is to be bought and a building erected arrangements must be made to operate from that location for very many years, anywhere from twenty to fifty years, as the moving of a central-office location may involve great losses. Obviously, it would not be economical nor practicable to erect a building at once which would be large enough to care for the needs of the company for anything like fifty years. As a matter of fact, it is economical to plan a building sufficiently large to care for the needs for about ten years.

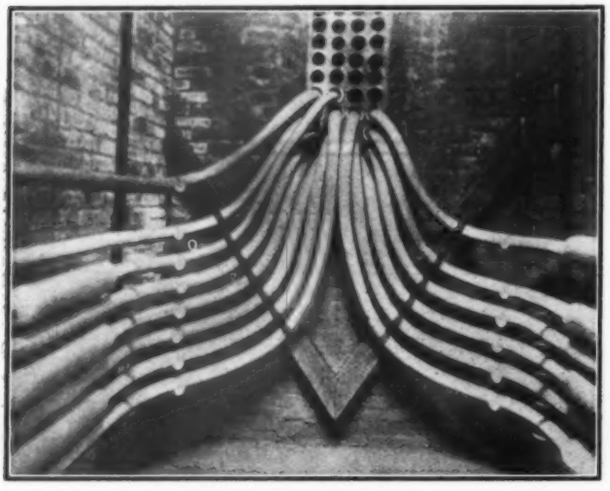
What is done, therefore, is to purchase an adequate lot, plan a building to care for the space which it is estimated will be required in about ten years and arrange the building so that it can be extended on the lot, and with walls and foundations sufficiently strong to carry additional floors. In this way practically all the money that is spent at first is based merely on the growth which is expected in approximately ten years, but the plant is arranged so that additions can be made to carry on the business very much longer.

Manhattan was the first borough to be changed over from the old magneto substation equipment to common battery. Brooklyn and Richmond (Staten Island) followed, although the lower part of Staten Island still has some magneto substations, which will be changed over to common-battery service during the coming year. In Queens, all but one exchange has been transformed, and for this exchange (Astoria), a common-battery board is now under construction. The lower part of The Bronx was taken care of at about the same time as Manhattan. In the upper portion of The Bronx common-battery boards were installed during the year 1910, with the exception of Williamsbridge, which will be changed over in the early part of 1911.

POWER PLANT.

The power plant of the New York Telephone Company consists of electrical machinery for charging the common storage battery and for delivering ringing current. To charge the eleven-cell storage batteries, which are amost universally used for signalling and talking current, charging equipments are provided in duplicate, or, in some of the important exchanges, in triplicate. On certain circuits a somewhat higher voltage is used.

Low-frequency (sixteen cycles) alternating-current motor-generators are employed for ringing. To operate biased bells at subscribers' stations, a split alternating-current wave is used. The use of positive and negative pulsating current on the two sides of the line gives four combinations, on bells legged to ground. The same result is accomplished by the alternative method of superposing a direct current on an alternating current, by connecting an alternating circuit in series with a stor-

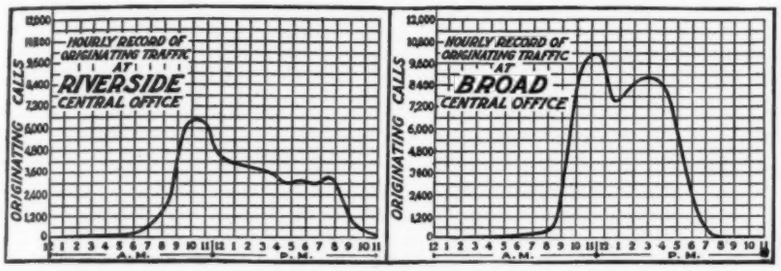


INTERIOR OF MANHOLE.

DISTRIBUTION OF LINES IN SUBURBAN DISTRICT.

age battery, with the advantage of giving a smooth-wave ringing current.

An efficient breakdown service is provided in every exchange, in order to avoid any possible interruption; there being either two independent



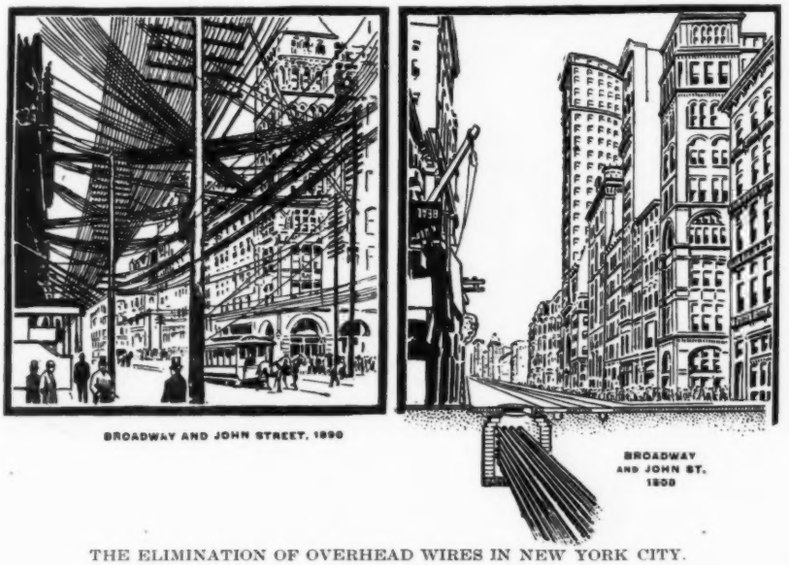
CONTRAST BETWEEN THE TELEPHONE LOAD CURVES OF AN UPTOWN RESIDENCE EXCHANGE AND A DOWNTOWN EXCHANGE IN THE FINANCIAL DISTRICT.

services from the street mains—different entrances from different ducts—or the street mains and an isolated generating plant driven by a gas engine. Three of the larger exchanges in Greater New York have an isolated (steam-electric) plant supplying motor-generators. For the remaining exchanges, power to supply the batteries and for ringing purposes is obtained both from a gas engine belted to a generator and from the street mains.

PRIVATE BRANCH EXCHANGES. PAY STATIONS.

The telephone unit from the viewpoint of the public is, of course, the individual telephone instrument. In the elementary telephone connection the subscriber makes the call himself, and this method was the one universally used up to the introduction of the private-branch-exchange switchboard which was about seventeen years ago.

The private-branch-exchange switchboard (P. B. X.) has revolutionized the telephone service of large cities. It consists of a small or medium-sized switchboard with two or more lines to the central office, and to it are brought the loops from a number of telephone instruments distributed at convenient points through the offices or other premises of the subscriber. The number of telephones may be very much larger than the number of lines to the central office, and the P. B. X. operator (who is an employee of the subscriber) performs valuable service in saving the time of the principles and entire office staff on both local and long-distance telephone calls. By her work also she facilitates intercommunicating telephone service among the different departments in the subscriber's premises. Some idea of the development of the P. B. X. business of the New York Telephone Company may be gathered from a comparison of the following figures. In 1900 New York City had a total of 1,050 private branch exchanges located on subscribers' premises and serving 12,650 telephones. Today it has over 12,000 of these exchanges serving 164,000 telephones.



THE ELIMINATION OF OVERHEAD WIRES IN NEW YORK CITY.

New York City is a great field for the use of the telephones at public pay stations, as the telephone is employed freely to save valuable time that would otherwise be consumed in long or short trips in cars or trains. In all of the hotels, railroad stations and other public and semi-public buildings, and in countless drug stores, cigar stores, barber shops and other places frequented by the public, may be found pay-station instruments. At these places the equipment is of various kinds, ranging from a number of telephone booths under the supervision of one or more branch-exchange operators down to a single instrument without an attendant and controlled by a nickel-in-the-slot pay-station mechanism constructed to allow the central-office operator to refund the customer's nickel if the line is busy, or if for any other reason the connection is not completed.

The total number of pay stations in the five boroughs of Greater New York is 39,000, and of these 8,500 are automatic stations and the remainder are instruments in booths under the supervision of an operator.

CABLES AND WIRES.

The telephone lines of Greater New York (from the telephone instruments to the central offices and the inter-exchange trunks) consist almost wholly of cables of wires, either underground, submarine or aerial. By virtue of a law passed by the New York State Legislature in 1888, no overhead wires are permitted to be strung in cities of 500,000 population and over.

It is not necessary in this article to go into the subject of paper telephone cables, a subject constituting in itself an important chapter in telephone engineering. The standard dry-core underground cable now in use in the metropolis contains 600 twisted pairs of No. 22 paper-insulated conductors, with standard lead sheath, adapted to be pulled into the standard 3.25-inch duct. This small size of wire was adopted five or six years ago, replacing the use of No. 19 wire and the corresponding smaller number of pairs possible to go into a three-inch cable.

In the outlying districts, and at the terminals of underground cable runs,

where a group of substations is to be reached—such as the telephones in the rural suburban houses, for example—aerial cables and open wire or twisted pairs of rubber-covered wires are employed.

The question of submarine cables has been an important one, owing to the great waterways that separate Manhattan and The Bronx from the other boroughs of Greater New York and from New Jersey, namely, the East River and the Hudson River.

Following the success of an experiment, made by Frank A. Pickernell some years ago, of laying standard lead-covered paper-insulated cables, protected with an armor of iron wire, in place of the old-style heavily armored cables of rubber-covered or gutta-percha-covered wire, this practice has been consistently followed, resulting in much better telephone service, and a diminished amount of repairs.

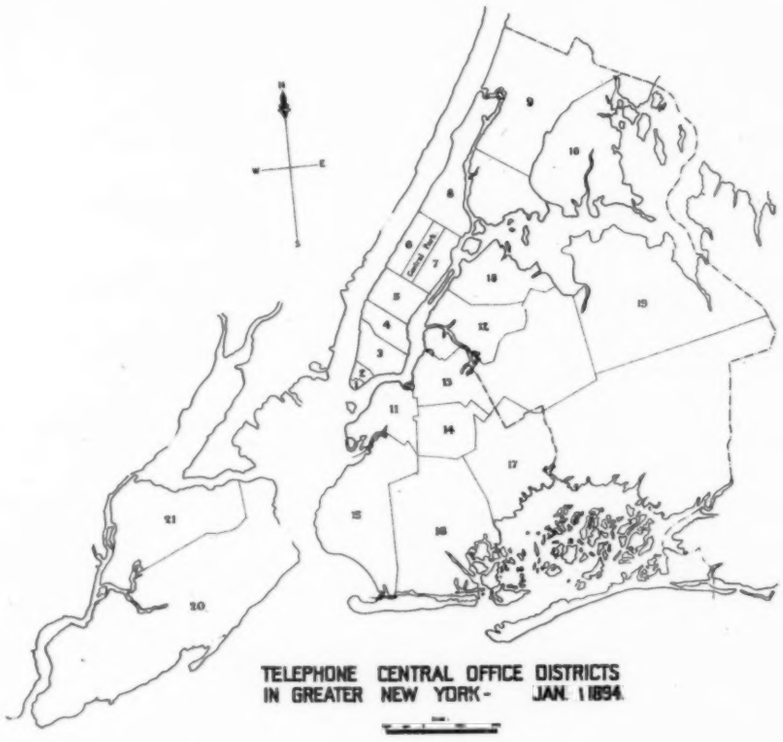
CHANGES IN CONSTRUCTION EQUIPMENT.

In the New York telephone system improvements and changes have followed one another at close intervals during the entire period of the company's existence. Three times in sixteen years the entire system has been practically rebuilt; and several of the central offices have been rebuilt as often as three times in ten years. The other major features of reconstruction are the changing from the overhead grounded or single-line system to an entirely underground metallic-circuit or double-line system, and the changing of the central-office switchboard equipment and the subscribers' stations from the magneto-call and local-battery system to the present common-battery system.

On new construction during the first six months of 1910 the New York Telephone Company spent about four million dollars. The reserve equipment of the company is 30 per cent of the whole, comprising spare conduits, pairs of wires in underground and aerial cables, cables reaching into nearly all buildings in each city block, switchboard capacity, private-branch-exchange switchboards equipped and ready for installation, desk and wall telephones, and duplicate, and in some instances, triplicate power plant.

VOLUME OF TRAFFIC AND LOAD CURVES.

The total number of originating calls in Greater New York for the twelve months, December, 1909, to December, 1900, was 470,155,700. The total substations in service December, 1, 1910, was 396,572, a growth of 331,944 in ten years. The telephone traffic represents the business and social activities of each section of New York City, rising and falling as these activities increase and decrease. The group of busy down-town exchanges in Manhattan presents some interesting features. In the main telephone building, running through from Dey to Cortlandt Street, near Broadway, three exchanges are located, "Cortlandt," "Rector" and "Barclay." The Rector and Barclay exchanges are served on one switchboard.



The Cortlandt exchange is the largest in the country in number of subscribers and number of operators' positions. The "A" board is 176 feet long and is divided into thirty sections. The "B" board is 82 feet long, with eighteen sections. The capacity of the "A" board is 9,000 lines, with 840 outgoing trunk lines to other exchanges. The "B" board has the same capacity for Cortlandt subscribers and 1,000 incoming trunks from other exchanges, making a complete double-track system. The board contains over 500,000 spring jacks and about 141,000 incandescent lamp signals. The number of soldered connections runs into the millions.

The Rector exchange is the busiest in the average number of calls per subscriber's line. The Rector, Broad, Hanover, John and Cortland exchanges are classed together in importance with relation to the down-town telephone traffic of Manhattan, the aggregate number of telephones in these five exchanges being approximately 53,000. The curve of Broad shows the rush of business which comes with the opening of the financial exchanges, business houses and institutions, the lull during lunch hour and the rapid cessation of all activity shortly after 4 p. m. Riverside is typically residential, showing the peak load during marketing hours, and the calls kept up until a late hour in the evening. Murray Hill, serving the theater, restaurant and club district, shows the activity of the "Great White Way" throughout the evening. New York's busiest hour is between 11 and 12 a. m., with 180,000 calls.

The following statistics indicate the number of telephones in certain large single buildings in New York City:

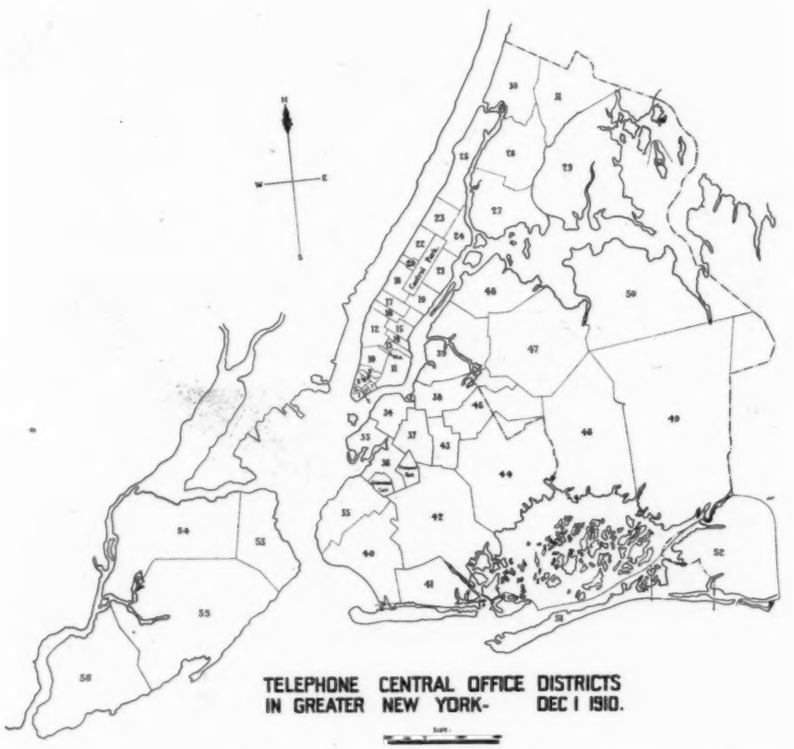
Building	Height in Stories	Miles of Wire	Number of Telephones
Hudson Terminal	22	750	3000
Metropolitan Life	46	680	2000
City Investing	40	450	1300
Singer	40	230	1300
Broad Exchange	50	250	1600

RECORDING CALLS.

To keep a record of subscribers' calls, the New York Telephone Company now uses an individual automatic registering device, designed by the Western Electric Company, on each pair of cords, replacing the "peg-count" method formerly used. This device is similar in construction to a revolution counter or bicycle cyclometer, but electromagnetic in operation. It consists of dial wheels bearing numbers on their peripheries. Each register is operated by a push button closing the circuit of an electromagnet and causing the dial to register one unit. One of these registers is permanently connected to each subscriber's line and one register is permanently connected to each "A" operator's position. These registers can only be operated when the "A" operator presses a button. As described above, when two subscribers have completed their conversation and have hung up their receivers, both the supervisory lamps, in the cord circuits in front of the "A" operator, light up. The "A" operator then pushes the message-register button of that pair of cords. This registers one call on the message register connected to the line of the subscriber originating the call, registers one call on the message register connected to the operator's position and also lights a lamp which indicates to the operator that the message registers have operated. The register will not operate on pushing the button unless the cord associated with that button is connected by its plug to the subscriber's jack. All the registers are assembled in an iron rack inclosed in dust-proof cases. In this way a correct record is had of the calls originating on each subscriber's line and of the calls handled on each operator's position.

DIRECTORY.

The mere bulk of the Greater New York telephone directory is an index of the magnitude of the service afforded. Every four months 500,000 new directories are distributed, one for each telephone, and the old books are collected and returned to the company.



The present book is 9 by 11 inches, 1:25 inches thick, contains about 235,000 subscribers' names and addresses printed on 650 pages, and weighs 3.5 pounds. The mere distribution requires 500 men, fifty horses and twenty-five trucks and takes eight or ten days to complete.

OPERATING.

In answer to the demand for a quick telephone service, seconds and fractions mark the time in New York City telephone operation. Averages from a large number of actual observations give the following figures: To receive a call and repeat it to calling subscribers, 7.5 seconds; to connect and ring called subscriber, 13.5 seconds; subscriber's time in answering, 10.5 seconds; to disconnect after conversation is completed (supervisory lamp lighted), 3.8 seconds. In New York and vicinity there are 185 central offices connected by 20,000 trunk lines and serving over 500,000 telephones. The operator must be prepared for every contingency that may arise, and know the proper routing on any call, and must start each call along its proper channel without an instant's hesitation.

STATIONS IN SERVICE AND NUMBER OF OPERATORS' POSITIONS.—DECEMBER 1, 1910.

Number on Map.	Exchange—	Stations in Service.	Number of Operators' Positions.
	MANHATTAN AND BRONX.		
1	Broad	12,678	121
5	Cortlandt	17,299	126
3	Rector	9,968	120
6	Barclay	3,088	...
4	John	10,601	99
7	Beekman	5,225	...
2	Hanover	2,333	99
9	Franklin	6,987	90
8	Worth	6,264	94
10	Spring	14,859	122
11	Orchard	7,301	66
12	Chelsea	10,529	91
13	Stuyvesant	7,947	75
14	Gramercy	10,732	86
15	Madison Square	19,769	102
16	Murray Hill	13,140	97
17	Bryant	17,918	89
18	Columbus	17,165	95
19	Plaza	13,775	67
20	Schuyler	4,374	50
21	Lenox	10,197	63
22	Riverside	19,764	92
23	Morningside	21,405	74
24	Harlem	8,205	78
25	Audobon	20,303	53
26	Marble	67	1
27	Melrose	8,615	75
28	Tremont	5,388	45
29	Westchester	725	6
30	Kingsbridge	420	4
31	Williamsbridge	611	6
32	City Island	111	2
	Total	307,763	2,188
	BROOKLYN AND QUEENS.		
33	Hamilton	1,945	33
34	Main	12,397	105
35	Bay Ridge	3,235	35
36	South	4,231	41
37	Prospect	9,915	66
38	Williamsburg	6,845	78
39	Greenpoint	4,158	61
40	Bath Beach	2,306	22
41	Coney Island	2,247	32
42	Flatbush	7,053	38
43	Bedford	9,843	88
44	East New York	3,413	52
45	Bushwick	5,230	55
46	Richmond Hill	1,828	13
47	Newtown	1,097	13
48	Astoria	923	11
49	Jamaica	1,812	21
50	Flushing	2,516	22
51	Hammels	772	15
52	Far Rockaway	1,979	24
	Total	83,745	825
	RICHMOND.		
53	Tompkinsville	2,547	17
54	W. New Brighton	1,827	16
55	New Dorp	356	5
56	Tottenville	334	3
	Total	5,064	41
	Grand total	396,572	3,054

OPERATORS.

The necessity for a high ideal of telephone service, dependent upon the conscientious work, good physique, good nature, address and general capability of the operating force, has been a well

defined point with the traffic department of the company for many years. About 6,000 girls are employed as switchboard operators. In order to maintain a standard high efficiency of service, the company has a training school where applicants for positions as operators are put through a course of training lasting three to four weeks. All applicants are paid while trying to fit themselves for the work whether they are finally accepted or found wanting in efficiency. About 17,000 girls apply for admission to the school annually, of which number only about 2,000 are selected.

The company has recently substantially advanced the salaries of the operators, besides arranging to shorten the hours of all the evening operators from eight to seven and the day and night operators from nine to eight hours. About 800 new operators will be required to maintain the present service under the new rules. The company also provides at each exchange large and comfortable retiring rooms under the supervision of matrons and equipped with divans and easy chairs, and also supplied with newspapers and magazines. A sick bay is also provided. Tea and coffee are served free in the lunch rooms at all hours for the operators.

ADVERTISING.

Educating and training the public to a proper appreciation and use of the telephone is part of the duties of the Advertising Department, and among its methods is the placing of a series of instructive, illustrated advertisements in the daily newspapers from time to time.

The New York Telephone Company last summer began to publish a monthly periodical called *The Telephone Review*. A copy of this house organ, a large and well edited publication, goes to every employee of the company. The employees are invited to contribute, to ask questions and to make suggestions or comments which are of an educational nature or of mutual benefit.

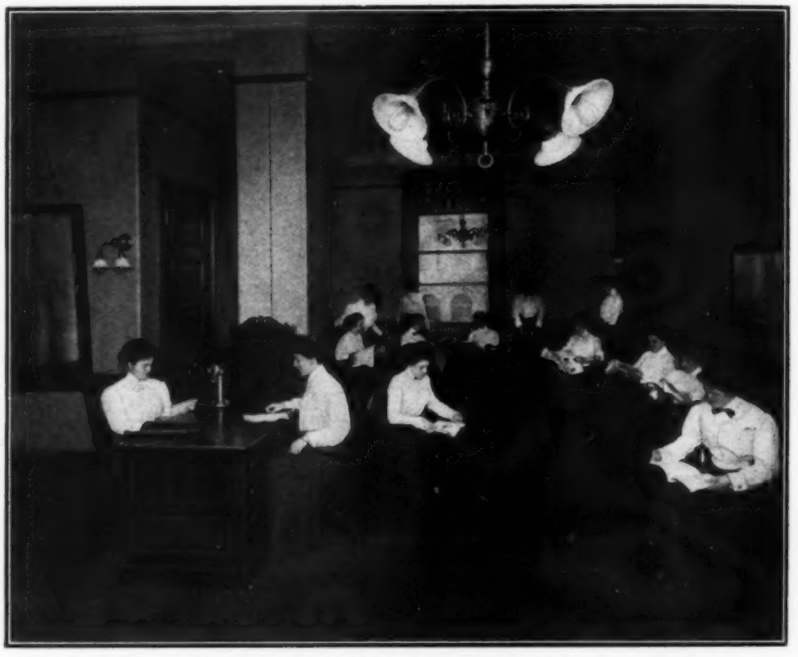
Exhibition of School of Engineering.

The fifth annual electrical exhibition of the work of the students of the School of Engineering in Milwaukee, Wis., was held on February 16, 17 and 18. The exhibits consisted largely of work done by the students in the electrical laboratory.

Meeting of National Electrical Jobbers' Association.

A meeting of the National Electrical Jobbers' Association was held at the French Lick Springs Hotel, French Lick, Ind., on February 15, 16 and 17. Matters relating to the business of the jobbers was discussed at several meetings presided over by Franklin Overbagh, general secretary of the Association.

At one of these meetings W. W. Merrill, of the National Board of Fire Underwriters, talked most interestingly of the advances made in the safeguarding of lives and property. Mr. Shindler, of the National Policy Holders' Union, addressed the members about fire insurance policies and the advisability of a better understanding of them on the part of those paying the premiums.



OPERATORS' RETIRING ROOM.

The next meeting of the association will be held at Del Monte, Cal. A special train has been arranged for, to leave Chicago, April 18. A day will be spent at Grand Canon and another at Los Angeles while en route.

Among those present were: Charles E. Brown, F. C. Ringgold, Central Electric Company; James Clark, Jr., W. S. Clark, James Clark, Jr., Electric Company; C. A. Munger, American Washer Company; Charles I. Hills, P. S. Klees, F. E. Wolcott, Franklin Electric Manufacturing Company; M. A. Gurney, Tungstolier Company; E. E. Hudson, Edison Manufacturing Company; B. F. Lyons, National India Rubber Company; James Richardson, Electric Machinery Company; E. E. Dewey, Paragon Sellers Company; H. A. Brereton, General Incandescent Lamp Company; A. E. Williams, Colonial Electric Company; Robert E. Gorton, New York & Ohio Company; Harry B. Ramey, W. A. Myers, Robbins & Myers Company; W. A. Stacey, W. W. Low Electric Appliance Company, S. B. Condit, Jr., Condit Electrical Manufacturing Company; Gerald W. Hart, G. C. Palmer, Hart Manufacturing Company; H. B. Crouse, A. F. Hills, C. M. Crofoot, Crouse-Hinds Company; Frederick Greer, Harvard Electric Company; H. H. Cudmore, Brilliant Electric Company; Ross D. Holabird, Holabird-Reynolds Electric Company; A. C. Garrison, Columbia Incandescent Lamp Company; F. B. Adams, Frank Adams Electric Company, Russell Dart, Alphaduct Manufacturing Company; J. H. McGill, McGill Manufacturing Company; Julian S. Jackson, International Electric Meter Company; W. H. Coleman, General Electric Company; E. W. Rockafellow, Western Electric Company; B. B. Downs, St. Paul Electric Company; H. B. Kirkland, American Conduit Manufacturing Company; C. E. Corrigan, National Metal Molding Company; D. C. Hemingray, Hemingray Glass Company; L. H. Keller, Union Electric Company; B. M. Downs, Brookfield Glass Company; J. B. Terry, J. B. Terry Company; M. G. McGraw, Interstate Electric Company; F. M. Bernardin, B. R. Electric & Telephone Manufacturing Company; E. Bernard, E. G. Bernard Company; George L. Patterson, Stanley & Patterson; N. C. Cotabish, National Carbon Company; W. S. Bissell, F. Bissell Company; C. O. Brandel, Warren Electric & Specialty Company; H. P. Andrae, Julius Andrae & Sons Company; Charles Phillips Hill, Doubleday-Hill Electric Company; R. E. Lucas, Marion Insulated Wire & Rubber Company; Paul F. Bauder, National Electric Lamp Association; Albert C. Hofrichter, F. W. Wakefield Brass Company; J. B. Estabrook, Colonial Electric Company; W. N. Matthews, W. N. Matthews & Bros.; J. G. Pomeroy, Adams-Bagnall Electric Company; J. H. Trumbull, Trumbull Electric Manufacturing Company; Oscar Turner, Southern Wesco Supply Company; H. B. Scott, Syracuse Supply Company; V. C. Gilpin; Alfred Smith; M. L. Spaulding, Westinghouse Electric & Manufacturing Company.

Chicago Section, Illuminating Engineering Society.

The February meeting of the Chicago Section of the Illuminating Engineering Society was held at noon on the 16th after the customary luncheon in the Chicago Room of the Great Northern Hotel. The topic for general discussion was "Illumination Problems in the Smaller Cities."

J. R. Cravath stated at the outset that the problem of getting anything like decent illumination in the small city is largely up to the central-station company. In the stores the custom of suspending the lights at about the level of the eye by means of drop cords is still sadly prevalent. It is difficult to convince storekeepers that the lamps should be raised out of the line of vision and still more difficult to get them to equip the lamps with diffusing and reflecting glassware. Especially is this true where there is competition with gasoline lighting systems. But much educational work has been done by central stations in many small communities and as a result there are to be found a considerable number of model store-lighting installations. In the small towns the small residences and cottages form a large part of the load. To increase the efficiency of residence lighting means a satisfactory increase of load. Drop-cord installations are still quite common; they must be replaced by tungstens near the ceiling and provided with pendent switches. The fixtures available in the small town are generally abominable. For street lighting the custom of placing an arc lamp at every other intersection still prevails in many places because of lack of funds; the resulting lighting is sadly disappointing. The solution is to put 100-watt, or larger, tungsten lamps at each street crossing. To show that good street lighting is feasible in a small city, Mr. Cravath cited the case of Albert Lea, Minn., a town of 6,000 population, where sixty-watt tungsten lamps are placed on ornamental posts about fifty-five feet apart in the residence streets. On the main street three-light tungsten clusters are used.

Charles A. Luther told of a case in a New Jersey town where a tactful electric lighting of two signs on either side of a stubborn merchant's store secured him finally as a satisfied customer of the lighting company and resulted in getting many other contracts. But there is a great field for educating the public to what really constitutes good lighting.

A. L. Eustice said he had noticed a general lack, or improper use, of reflecting devices. He spoke of a case where a lady had too large a lamp for the lighting of her library. To overcome this she had ingeniously arranged about the lamp a yellowish-white silk shade from an old umbrella.

C. A. Howe stated that until a few years ago gasoline plants were general in the smaller cities for store lighting particularly. Now there has come a marked awakening to the advantages of efficient electric lighting and practically all the gasoline is being driven out. Concerted campaigns have been instituted by central-station men with the aid of lecturers from among the manufacturers. A strong educational movement to teach what constitutes good lighting has set in with very gratifying results.

J. G. Learned spoke of the marked value of popular lectures on illumination when delivered by a competent man. The apathy of the public must be overcome. The experience of the North Shore Electric Company has been that where it wires a house ample provision is made for good lighting; when a contractor does the job this is seldom true. The solicitors of the company at first did not take kindly to illuminating engineering; now that they understand it better they realize its great value to them. Mr. Learned advocated getting the interest of the popular magazines in advancing the cause of good lighting.

Vice-President H. E. Ives said it was a pleasure to him to be present at the meeting of the Chicago Section, as he was now its spokesman in the Council of the Society. He brought the official announcement of the selection of Chicago for the next convention. Touching on other matters of Society interest, Dr. Ives expressed the opinion that missionary work should be undertaken by the Society through co-operation or joint meetings with ophthalmologists, physicians, educators and even ministers with the idea of spreading the gospel of good lighting.

General Secretary P. S. Millar made a brief address on the great strides that the Society made last year and the keen interest taken in its welfare as evidenced by the large attendance at the preceding meeting of the Council. He also touched on the financial condition of the Society and its excellent prospects for greater influence and growth.

Directive Wireless Telegraphy.

To the Editor:

In your issue of January 7, we notice that you refer to the fact that our directive system of wireless telegraphy has been tried successfully on warships of the French navy, but that the range is limited and the wave employed very short. In this connection we should like to point out that the French naval authorities have never tried our directive system of wireless telegraphy but only the "wireless azimuthal compass," which is a special application of the receiving portion of our directive system.

The wireless azimuthal compass allows of a ship determining the bearing of an invisible radiotelegraphic transmitting station with an approximation of one degree; that is to say, with the same degree of accuracy which is obtained by the use of the ordinary magnetic azimuthal compass in the case of a visible object. In consequence, our wireless compass permits a ship, when navigating in the vicinity of one or more invisible radiotelegraph stations, to keep her course with the same exactitude as she would by aid of measurements with the ordinary instruments of navigation and visible objects. This means that the wireless compass enables the ship to make her exact objective point when in the neighborhood of the coast in time of thick fog, just as though the weather were quite clear, a thing which cannot be done by ordinary methods. And since bearings are never taken at greater distances from the coast than thirty miles, it happens that the trials of our "radio-compass" were made at that distance in the French navy tests.

For the coast stations which are to emit waves exclusively for the radio-compass service, we contemplate using short waves because these are preferable for the short antennæ of the radio-compass, but chiefly in order to avoid the disturbing influence which the emissions for the radio-compass might have on the commercial wireless communications with the ordinary wave-lengths which might be carried on at the same time.

E. Bellini and A. Tosi.

SOME GEOMETRICAL ASPECTS OF THE THREE-CHARGE-RATE SYSTEM.—III.

BY HUGO E. EISENMENGER.

EFFECT OF DIFFERENT RATES ON THE CENTRAL STATION.

(Continued).

It has been shown that the central-station plane always has to pass through the real point of rates P_o, whatever the character of the average customer's supply may be, and therefore if the central-station plane will swing towards the position of the favored-customers' plane, the only way to do this is to swing around P_o as a fixed point—for instance, into position $Q_x\ Q_y\ Q_z$ (Fig. 10) approaching the inclination of the plane of the average *favored* customer—which may be represented by R_1 or R_2. It is then seen from Fig. 10 that P_m is no more on the new central-station plane but "below" it and in order to reach the latter the charges would have to be raised; for instance, if x and y shall be kept constant z had to be raised from P_m' P_m to P_m' P_n.

If the point P_o involves a certain percentage of profit[14] over expenses to the central station then all points on the central-station plane will bring the same percentage profit. The plane of the central station under the changed conditions is now Q_2 and consequently P_n would correspond to the same percentage profit as P_o, whereas P_m, which is the point of rates reached by shifting along the *original* plane of the central station, will bring a smaller profit than P_o, since P_m is below the present central-station plane Q_2. In other words, the effect of *moving the rates point away from the true rates point is to reduce the average percentage profit* of the electric light company as a result of the change of the character of service the customer will use, that is, in consequence of the accumulation of favored customers, since the latter contribute less to the central-station's income than is their share according to the expenses they cause. (A decrease of the *percentage* profit does not necessarily involve a decrease of the *absolute* amount of profit, as will be shown in what follows, since the volume of business done may change also.

On the other hand, if the rates point is shifted in such a way that it is nearer to the true point of rates in its new position than it was in the old one, this will mean an increase of the percentage profit.

If instead of actually shifting the rate point we compare two separate central stations, the true rate points of which are P_1 $(x_1\ y_1\ z_1)$ and P_2 $(x_2\ y_2\ z_2)$, respectively, it can be seen what classes of customers will be attracted by each plant.

Thus, for instance, let P_1 represent a steam plant, P_2 a water-power plant. P_1 then will generally have larger kilowatt-hour charges z than P_2, especially at high fuel prices, and P_2 will show high demand charges, owing to the large capital invested per kilowatt in construction and transmission work. Supposing the customer expenses to be the same in both stations, we get the two points P_1 and P_2 in Fig. 11. If both stations would compete in supplying the same territory they will perhaps, just for the reason of being competitors, both adopt the same rates.

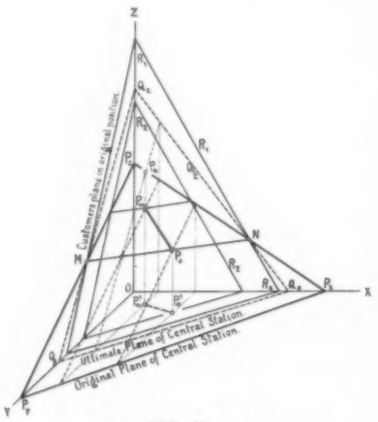


FIG. 10.

Let them now get to an understanding or, for instance, be amalgamated, and both be controlled by the same concern, then it will be obvious that they will do the maximum business if they apply different rates according to their respective true ratepoints[15]. The line of connection $P_1\ P_2$ has the direction of the load-factor line in Fig. 6, x being constant. The rate point of the water-power plant is on the side where the large-load-factor consumers are favored and therefore the water-power plant will attract the customers with large load-factors, whereas the short-hour users will find out that they are served more cheaply by the steam-plant. Consequently, the planes of the two plants will assume different angles towards the axes and a larger amount of business will be attracted than at uniform rates.

If, for some reason, the customer expenses in both plants be also different, the line P_1P_2 in Fig. 11 will assume a direction either between the load-factor and the energy line in Fig. 6, or between the load-factor and the demand line. Thus if the steam plant has the smaller customers' expenses of the two, it will prove especially attractive to those small-load-factor customers who have a small energy consumption; in the opposite case, to those with a large maximum demand, etc.

If the two plants, instead of each cultivating its own field, have been competing with each other by making equal charges, the result will be that each plant has to carry a number of customers at small profit or even at a loss who would be of profit to the other one and also that the total amount of business decreases for a given amount of average percentage profit, since the customers with very low and very large load-factors cannot be reached any more. (It is, of course, possible that for special business reasons which have nothing to do with theory and outweigh the above-named results it may be good policy in special cases to compete on the basis of equal rates.)

DISCRIMINATION BETWEEN CUSTOMERS.

There is a theory among some central-station men that the individual customer should not be charged according to what it costs to supply his service, but according to what it would cost him to obtain his service elsewhere. This would mean, for instance, that a large factory or office building should be served at a lower profit per unit than the small customer, since the large factory can install a generating plant of its own and, therefore, obtain current at a price not much above the output cost of the central station.

If a central station works, for instance, at a profit of 15 per cent over their output cost their price on the basis of equal profit from all customers would be 115 per cent. A large consumer may be able to generate his own electricity at a cost of, let us say, 110 per cent. He could not be reached at the normal price of 115 per cent, but if current is offered to him at, for instance, 105 per cent he will become a customer

14 The term "percentage profit" in this and the following cases always refers to percentage of expenses or income and not to percentage of capital invested.

15 The supposition is made that the two plants for some reason cannot work in parallel.

x=the customer expense in dollars per customer per year;
y=the demand expense in dollars per kilowatt of maximum demand of the customer per year;
z=the output expense in dollars per kilowatt-hour sold;
C=the average number of customers;
D=the sum of the customers' maximum demand;
E=the energy sold per year in kilowatt-hours;
A=the amount of the total expenses for multiple service in dollars.

and yield 5 per cent profit instead of nothing in the other case. The average percentage profit of the central station is reduced, but the volume of business at the same time is so much increased that the absolute amount of profit in dollars and cents is enlarged.

It is not the object of this article to enter upon the question whether the equal-profit plan or what might be called the discriminating plan is theoretically and commercially correct, but it shall be shown here that the three-rate system permits the application of the latter plan in such a way that the charge of undue preference cannot be raised.

It is obvious that a reduction of price of electricity will increase the number of customers, but there is a certain limit to that increase. Even if electricity were given absolutely free the number of customers would not increase into infinity and in the same way there is a certain maximum of the sum of the maximum demands and of the kilowatt-hours consumed. Any charges made on these three determining factors will bring their total down. A charge made on the kilowatt-hour consumption will exclude a certain number of one class of these prospective customers; a charge on the maximum demand another class; and a customer charge, a third class. If all three charges are made simultaneously a certain percentage of each of these three numbers will see it advisable to abstain from connecting up to the company's lines, and it can be imagined that there are some very large consumers or perhaps a great number of small ones, etc., amongst them, who might be induced to connect up if the rate point in Fig. 6 was shifted towards the direction which favors them. Of course, there are other customers who will be lost just by this shifting, as they are moved by it into the "penalized" class, and the condition for the advisability of the shifting is that the profit derived from the totality of the customers gained by that process exceeds the profit from the lost customers[16].

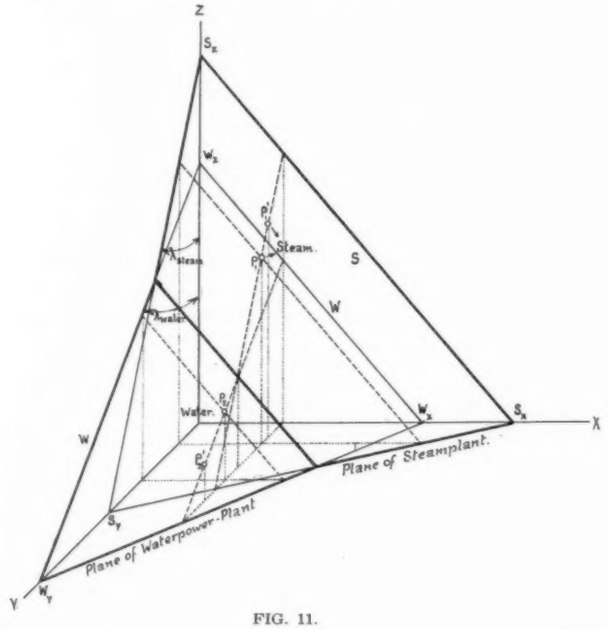


FIG. 11.

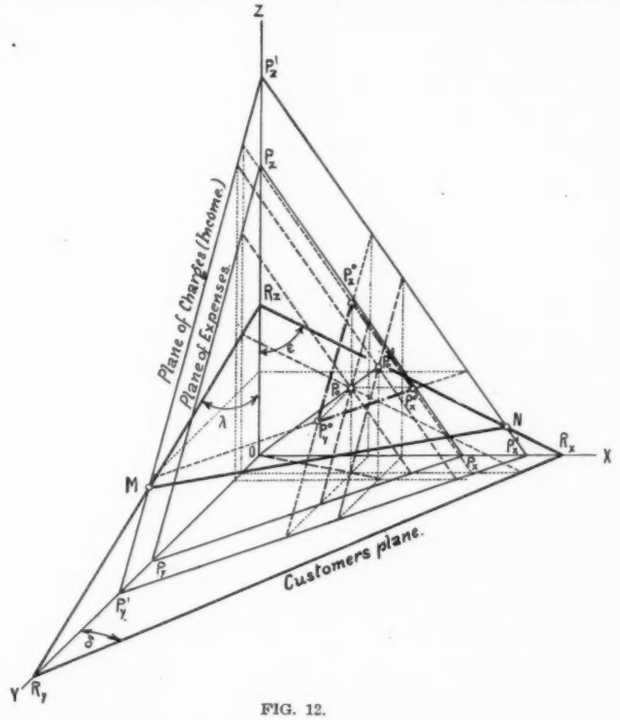


FIG. 12.

Thus in the example given above of the steam and the water-power plant it may be advisable to fix the rates still further apart than P_1 and P_2 in Fig. 11, for instance at P_1' and P_2', in order to reach a still larger amount of business. In that way some more consumers with very large and with very low load-factors may be added to the customers and be supplied at a profit to both producer and consumer, provided that there is a sufficient possibility for business of that character (extreme load-factors) in the territory to offset the loss of part of such customers, which would find the rates half-way between P_1 and P_2 most favorable.

It has been permissible so far for the sake of simplicity to make no discrimination between expenses and income, since everything that has been said applied to both. We have to establish now, however, a separate *plane of expenses* which can be found by analysis and subsequent synthesis of the expenses shown by the companies' books and another *plane of income*, or plane of revenues. The equation of the first-named one is our equation (1).

$$Cx + Dy + Ez = A \qquad (1)$$

and that of the income plane

$$Cx + Dy + Ez = I \qquad (1_1)$$

where I is the yearly income from the sale of current and has to be assumed at a certain percentage higher than A, $I = p\,A$.

16 Whether this actually takes place or not cannot be decided otherwise than by careful and intelligent estimation of the local conditions. This, of course, implies a certain amount of guesswork, but guesswork is always connected to rate making or to making of prices in general and cannot be avoided (for instance we have to assume a certain percentage of profit, without ever being able to hope that we will know exactly at which percentage the total amount of profit will be a maximum). In any case, the amount of guesswork will be very much smaller than it is if we confine ourselves simply to the YZ plane and assume the customer charges to be zero.

By applying the same reasoning to equation (1_1) as has been applied to (1) in the earlier part of this article it can be seen that both planes are parallel as their intercepts on the three axes are proportional.

Any point on the income plane will yield the same income I as long as the determining factors C, D, and E are not changed and just as we had a real point of expenses $x_o y_o z_o$ it may be expected that there is a real point of charges $x_o' y_o' z_o'$, which will warrant the income $I = p\,A$ under any set of values of C, D, E and A.

Assuming three different periods, characterized by the indices 1, 2 and 3 we have the following equations:

$$\left.\begin{aligned} C_1 x_o + D_1 y_o + E_1 z_o &= A_1 \\ C_2 x_o + D_2 y_o + E_2 z_o &= A_2 \\ C_3 x_o + D_3 y_o + E_3 z_o &= A_3 \end{aligned}\right\} \qquad (a)$$

and

$$\left.\begin{aligned} C_1 x_o' + D_1 y_o' + E_1 z_o' &= p\,A_1 \\ C_2 x_o' + D_2 y_o' + E_2 z_o' &= p\,A_2 \\ C_3 x_o' + D_3 y_o' + E_3 z_o' &= p\,A_3 \end{aligned}\right\} \qquad (i)$$

Solving equations (a) for x and (i) for x_o' we get

$$x_o = \frac{R_x}{R}$$

and

$$x_o' = \frac{R_x'}{R}$$

where R_x, R and R_x' are the following determinants:

$$R_x = \begin{vmatrix} A_1 & D_1 & E_1 \\ A_2 & D_2 & E_2 \\ A_3 & D_3 & E_3 \end{vmatrix}$$

$$R = \begin{vmatrix} C_1 & D_1 & E_1 \\ C_2 & D_2 & E_2 \\ C_3 & D_3 & E_3 \end{vmatrix}$$

$$R_x' = \begin{vmatrix} pA_1 & D_1 & E_1 \\ pA_2 & D_2 & E_2 \\ pA_3 & D_3 & E_3 \end{vmatrix} = p\,R_x$$

Therefore $x_o' = p x_o$.

In a similar way $y_o' = p y_o$ and $z_o' = p z_o$: the co-ordinates of the real rate point of charges are found from the co-ordinates of the real rate point of expenses by raising them in the same percentage as the expenses have to be raised in order to get the income; in other words, the real rate point of charges is the point of intersection of the plane of charges and a straight line connecting the real point of expenses with the origin O (P_o and P_o' in Fig. 12).

It is, of course, essential that no important class of customers is carried at a loss and it may therefore be of interest to see how far the rate point of charges can be shifted in any direction without reaching this limit. Let us suppose, for instance, that there was a certain large customer with a large energy consumption, *tan* ϵ, and a large load-factor, *tan* λ, whom we aim to reach, Fig. 12. Draw his individual customer's plane $R_x R_y R_z$ through P_o, which is the locus of all rates under which he would just cover the expenses he carries. This plane intersects the central station's plane of charges in the line MN. If the rate point be located on this line the income from this customer will just cover the expenses he causes without any profit; if the rate point of charges be moved from P_o' beyond MN he will be carried at a loss.

Drawing parallels to the three axes through the real rate point of expenses, P_o, we get three points, P_x^o, P_y^o and P_z^o at the intercepts of these lines with the plane of charges and it may be seen from Fig. 12 that as long as the rate point of charges P_o' is inside the triangle $P_x^o\ P_y^o\ P_z^o$ (that is, as long as none of the three classified charges x, y, z, is lower than the corresponding expense) it is impossible that any customer can cause a loss by being charged less than he costs. As soon as we transgress the boundaries of that triangle there will always be a certain class of customers possible—though perhaps not existing—who are charged less than the expenses they cause.

Moving the rate point from P_o towards MN means lowering the kilowatt-hour charges and it seems quite natural that we cannot go below a certain limit with the kilowatt-hour charges without turning some customers from profitable ones to the contrary. It is not quite as obvious to the train of thought into which we have been educated by the pure meter-rate system that we cannot go below a certain amount of customer charges either, as the meter rates, flat rates, and Hopkinson rates are doing inherently. If, instead of supposing that there was one large energy consumer with a large load-factor to be reached we assume that in the central station's territory there was a large number of small consumers (*i. e.*, small energy and small maximum demand) for instance, residences, then the line MN would be located between P_o' and the YZ plane. This indicates that although it may be good policy to lower the customer's charges in order to reach those residences which otherwise, perhaps to a considerable extent, would use other illuminants, still there is a certain limit below which we cannot go without allowing them to pay less than they cost and doing this considerable amount of business at a loss. The larger the advantage given to this class of customer, the more of them will become customers and the larger probably the loss will be. The largest possible error in that direction is to make the customer charges zero and leave them out altogether. This is exactly what the pure meter rate, the flat rate, and their combinations, as the Hopkinson and Wright systems, are doing. The rates must then be kept higher to all customers than they would be if the small customers were not favored (compare points P_m and P_n in Fig. 10) and thus the large-energy consumers and long-hour users who already are penalized are taxed still more heavily in order to make up for the loss, so that just this class, which in this case means the profitable class of customers, will be partly driven away and use, for instance, isolated plants. This reacts in a *circulus vitiosus* on the small customers by hindering the growth of the plant and withholding from it the means for cheap production of electricity which are available to large plants.

The absence of customer charges therefore means acquisition of loss-causing customers in place of other profitable ones who are lost thereby. The introduction of customer charges means attracting the profitable class and removing the unprofitable ones by either making them pay a more just amount or turning them away for the immediate present.

In spite of this, it does *not* mean that the small customers must be of necessity more heavily taxed than before—except in the beginning—since the acquisition of new large customers with the resulting enlargement of the plant, as shown above, will lower the classified expenses $x\,y\,z$ of the central station (lower the plane of expenses) and thus permit lower charges to all customers. If desired, the charges may be lowered at that time particularly to the small customers, by choosing the point of rates accordingly after the plane of expenses has been lowered by the acquisition of the large customers; in that way the small customer's bill may be made the same again as it was before the introduction of the customer charges, or even lower, although he is yielding

profit now to the central station instead of causing loss.

Thus the three-charge system will prove of advantage to both the central station and the customers.

SYNOPSIS.

The article deduces mathematically the possibilities of the three-charge system (customer, maximum-demand and kilowatt-hour charge) by means of solid geometry. The three charges—or their corresponding expenses to the central station, respectively—are used as co-ordinates in a solid rectangular system of co-ordinates and it is shown first that a certain income of the central station can be derived from an infinite number of combinations of the three charges, assuming tentatively that under all these different systems of rates neither the number of customers nor the maximum demand, kilowatt-hour consumption, diversity-factor, etc., of each customer would change. Each one of these combinations of rates is represented by a point in space, the so-called "ratepoint," the three charges being its co-ordinates. The locus of all these points yielding a certain income to the central station is a plane called the central station's plane. It is shown that this plane assumes such an inclination towards the axis that—if corrections are made for diversity-factor and losses—angles δ ϵ and λ (Fig. 1) represent by their tangents the central station's maximum demand, yearly kilowatt-hour output and load-factor.

There is only one point on this plane, the "real ratepoint" which gives the real "classified expenses" of the central station, *i. e.*, customers, demand and output expenses (or charges if profit is included). If charges are made according to this ratepoint, *all* customers will be charged according to the expenses they cause. All other ratepoints are only equivalents insofar as the total income to the central station for all these points is the same, but the individual customer will be "favored" or "penalized" according to the character of service he demands. One customer pays more, another one less, than his just share towards the expenses; others may even be carried at a loss. As the ratepoint is moved around on the plane different classes of customers are favored. The *average customer*, however—that is, the customer with average maximum demand and average kilowatt-hour consumption (consequently average load-factor)—will never be favored or penalized, but *always pays his just share of expenses, no matter on which part of the plane the ratepoint is located.*

The first object of the article is to examine what the exact influence is (*a*) on the individual customer, (*b*) on the central station, if the ratepoint is chosen not as the true ratepoint, but somewhere else on the central station's plane. To do this, it has been assumed that the point of rates has been originally on the true ratepoint and then shifted on the plane in different directions, and the effect is then investigated.

In shifting the ratepoint in a straight line away from the true point of rates, not only the average customer, but a number of other classes of customers will also see their bills unchanged. Introducing a system of plane rectangular co-ordinates (Fig. 2), with the individual customer's maximum demand as abscissas and his yearly energy consumption in kilowatt-hours as ordinates, this customer's service is determined by a point on this plane, his *characteristic point*. All customers whose characteristic points are located on a straight line drawn through the characteristic point of the average customer are not affected by the change of rates and this line is therefore called the "line of unchanged bills." Its direction depends on the direction in which the ratepoint has been moved on the central station's plane. The connection between these two directions is deduced in the article.

All customers whose characteristic points are on one side of the line of unchanged bills are favored, the other penalized.

Shifting the ratepoint from the true ratepoint so that (with a constant total income of the central station) the kilowatt-hour charges are unchanged (parallel to the x y plane) all customers with a *maximum demand* equal to the average will experience no change in the total amount of their bills, *no matter what their energy consumption is.* All customers with a smaller maximum demand than average are favored, those with a larger one penalized (or *vice versa*, according to whether the ratepoint is shifted towards increasing or decreasing maximum-demand charges) no matter how large the energy consumption or the load-factor is.

Correspondingly, if the ratepoint is shifted for unchanged demand charges, the only criterion whether a customer is penalized or favored is the amount of his energy consumption, and neither maximum demand nor load-factor takes any part.

Finally, changing the rates without changing the customer charges favors long-hour users (or short-hour users respectively) without any regard to whether they are large or small customers (as regards either kilowatt demand or kilowatt-hours consumption).

In Figs. 7 and 8 another method has been chosen to show the influence of changing rates on the customer plane. The two horizontal co-ordinates are the customer's maximum demand and energy consumption; the horizontal plane of co-ordinates, therefore, is identical with the plane of Fig. 2. Each customer's service then is characterized by a point of this plane. The third (vertical) co-ordinate is made equal to what the customer has to pay per kilowatt-hour consumed by him under a certain system of rates. (One figure for each combination of charges, in other words, for each point of rates on the plane of rates). For customers with large energy consumption the surfaces representing the cost per kilowatt-hour to the customer approach asymptotically the vertical co-ordinate representing the kilowatt-hour charge. No matter what the charges are, all surfaces have to pass through a point p_a with the projection p'_a where p'_a is the average customer's characteristic point, and p'_a p_a, or the ratio of total income of central station to number of kilowatt-hours sold is the price per kilowatt-hour to the average customer. Figs. 8a to 8k refer to various points of the plane of rates. The line of intersection of each surface with the surface (Fig. 7) belonging to the real ratepoint has been drawn in each figure. Its projection on the bottom plane represents the "line of unchanged bills." The corners of the triangle P_x,P_y,P_z (Fig. 1) are special cases of the three-charge system, P_y being the flat rate and P_z the straight kilowatt-hour rate. Any point on the trace P_yP_z represents the Hopkinson system (or the Wright system). Figs. 8k, 8l and 8m represent pure meter rates with arbitrary modifications for large users.

For each customer a plane can be constructed on the same principles as the central station's plane (Fig. 9). The plane of the average customer is identical with the central station's plane.

As regards the effect on the *central station* of the displacement of the ratepoint away from the true ratepoint it is shown in Fig. 10 that in order to maintain a certain percentage of profit over expenses, the point of rates will have to be ultimately raised higher than the original plane of rates would indicate, since the favored customers, that is, those who yield a small percentage of profit, will increase while the "penalized" ones (the most profitable ones) are driven away. This seems to indicate that it is the best policy to use only the real point of rates. It is shown, however, that there are exceptions to this rule, for instance, in the case of very large customers who would be able to erect central stations of their own, and therefore generate their own current at a price which would be below the central station's output price. In order to get these customers, the central station, therefore, has to be satisfied with a smaller profit than normal and this can be done *without special contracts* by shifting the ratepoint in a direction which favors this customer. The profit derived from this customer, although proportionately smaller than that of the rest, may yet help to keep the total expenses per unit down and thus benefit the total of the customers. The claim of undue preference to any individual customer or class of customers cannot be raised since all customers are charged by the same rates.

Another application of the geometrical aspect is given in the example (Fig. 11) of a steam plant and a water-power plant serving the same territory. The steam plant has comparatively low maximum-demand expenses and high operating expenses and the reverse holds true with the water-power paint. It is shown that it would not be good business policy if the plants would try to compete with each other by giving the same rates. In this case each one of the two plants would have to carry certain customers, who would be most profitable to the other plant, at small profit only, or even at a loss, whereas if the two stations maintained their rates independently according to their real expenses as shown by their particular "true point of rates," both will get just those classes of customers which they are naturally best fitted to serve. The ultimate result will be a benefit to both central stations as well as to the public.

It is further discussed (Fig. 12) how far a central station can shift its ratepoint from the true ratepoint without incurring the danger of carrying any customer at a loss, and it is shown that this danger is only avoided if none of the three charges is fixed lower than the respective expense. If the point of rates is shifted far enough on the plane of rates that any one of the three charges becomes smaller than the respective classified expense, there will be—in spite of the corresponding increase of one or both of the two other charges—a certain class of customers which is carried below cost. The most important application of this rule is the case where the customer charges are fixed too low or even left out entirely.

Trolley Freight Service.

Electric locomotives are to be put in operation on the Fort Dodge, Des Moines & Southern Railway for the operation of freight trains and with the new service the present 600-volt system will be changed to 1,200 volts. Since the development of the freight business on this road the gross receipts have more than doubled and now the income from freight alone is sixty-five per cent of the entire earnings.

The new locomotives now being built by the General Electric Company will haul 15 or 20 cars.

American Institute of Electrical Engineers.

Mid-Year Convention at Schenectady and Pittsfield.

The American Institute of Electrical Engineers held a mid-year convention on February 14, 15 and 16, the sessions being divided between Schenectady, N. Y., and Pittsfield, Mass. The headquarters were at the Mohawk Golf Club, Schenectady, where the Schenectady sessions were held. The convention opened with the session at this place on the afternoon of February 14. This was followed by a dinner and in the evening another technical session was held. Wednesday was Pittsfield day, a special train taking the members and guests from Schenectady to Pittsfield, with a brief stop at Albany. The plant of the General Electric Company at Pittsfield was inspected by the visitors and luncheon was served at the works. A technical session was held at Lenox Hall in the afternoon and was followed by a complimentary dinner to the visitors given in the Hotel Wendell. The special train returned to Schenectady in the evening. On Thursday luncheon was served at the works of the General Electric Company in Schenectady, and was followed by a tour of inspection through the plant. The convention was a great success in every way, the attendance being about 400.

OPENING SESSION.

The opening session on Tuesday afternoon was called to order by E. A. Baldwin, chairman of the local committee. He spoke of the interest of the Schenectady and Pittsfield Sections in the Institute and of the benefit to be derived by them by the meeting of the Institute at those points. An address of welcome was expected from the Mayor of Schenectady, but he was unable to be present. In the absence of President Jackson, Charles F. Scott was called upon to deliver an address.

Mr. Scott called attention to the great growth of the sections of the Institute and to the fact that the membership in the Schenectady and Pittsfield sections was now greater than the entire membership in New York eight years ago. Since that time the Institute has grown from 1500 to 8000 members and still greater increases were predicted. This has been largely due to the existence of the sections, and there is now a proposition on foôt to organize a section for New York City. The wide-reaching effects which the electric motor has had upon general industry, and the convenience of the varied sizes which are available was dwelt upon at length. He also referred to the influence of the engineer in public affairs and to the large questions which have been brought to the fore through his activity. He also pointed out the propriety of the technical men in the large manufacturing companies taking a prominent part in Institute affairs.

As none of the vice-presidents of the Institute were present at this session, D. B. Rushmore, one of the managers, was called upon to occupy the chair, and the remainder of the session was devoted to the reading and discussion of papers, all of the papers first being read and then discussed together. The first paper was by A. B. Hendricks, and was entitled:

HIGH-TENSION TESTING OF INSULATING MATERIAL.

In the introduction the author states that great accuracy in the high-tension testing of insulating materials is not yet attainable, due to the variability of the materials, the difficulty of exactly controlling all the conditions of test, and in many cases, to the unreliability of the apparatus and methods employed. The methods, results and conclusions of different investigators thus vary between wide limits and a close agreement between them is not to be anticipated.

The tests discussed in this paper are those for the determination of (1) ultimate dielectric strength and arcing voltage; 2 energy loss or dielectric hysteresis; (3) specific capacity. The testing apparatus required comprises four main elements, namely (1) alternating-current generator; (2) high-tension transformer; (3) controlling apparatus, and (4) measuring apparatus. The results of tests for dielectric strength and arcing voltage will depend to some extent on the power and regulation of generator and transformer. The critical, final moments of test are liable to be attended by high-frequency oscillations which sometimes form a complete flash over without leading to a dynamic arc. These oscillations have negligible influence on the voltage of normal frequentcy until a flash over or momentary arc occurs, which may be attended by a sudden drop in voltage sufficient to prevent the formation of a continuous arc. It is at this point that the influence of the energy available becomes important, while previously it is of small consequence, the load being extremely small. The author, therefore, recommends that apparatus be provided of capacity sufficient to supply the small charging and leakage current and the energy absorbed by dielectric hysteresis with the closest possible regulation and minimum distortion of wave form. The paper then discusses the most suitable apparatus illustrating a number of the more important parts. Generators of the distributed-field type are recommended as embodying the essential characteristics necessary. The transformer should be designed throughout as a power transformer and preferably for continuous full-load operation, as contrasted with the usual bulky and delicate constructions of large impedance. Regarding controlling apparatus, the voltage must be varied through a wide range in a perfectly regular manner without breaks or steps. To effect this many different methods are in use, but the generator field control is said to be by far the best for laboratory work. The spark gap for measuring voltage is discussed and the voltmeter coil in the high-tension transformer recommended. The methods of test are then discussed. Full descriptions of the testing devices and materials are given, and the adoption of standard methods and devices recommended. Spark gaps for oil testing are discussed particularly as adapted for testing transformer oil. Three forms of spark gap are considered: Electrodes arranged vertically in cup; horizontally, and horizontally on separate frames dipping in cup.

The paper discusses the characteristics of various insulating materials, dividing them into three chief classes: (1) liquid insulators; (2) viscous insulators and (3) solid insulators. A few of the general considerations are presented, supplemented by some characteristic results of tests on commercial insulating materials. In conclusion there are presented the results of a number of actual tests, in the form of curves.

This paper was followed by one by W. J. Wooldridge, entitled:

HYSTERESIS AND EDDY-CURRENT EXPONENTS FOR SILICON STEEL.

This paper gives the results obtained experimentally for the variation of hysteresis and eddy-current losses with the flux density in silicon-steel. It was found that the power of the flux density to which the loss is proportional did not have a constant value. For hysteresis this exponent has a value of about 1.6 up to 8,000 gausses, but increases rapidly above that and reaches a value of 3.0 at 15,000 gausses. The exponent for eddy currents has a value of 2.0 for low flux densities, but decreases above 8,000 and reaches a value of 1.6 for 16,000 gausses. The losses in transformers at high flux densities are greater than those computed from the ordinary formulas with constants determined at low flux densities, as the decreased eddy-current loss does not offset the increased hysteresis loss, as the eddy-current loss is small in thin sheets of silicon-steel.

The final paper was by H. A. Wilson, and was entitled:

COMMERCIAL PROBLEMS OF TRANSFORMER DESIGN.

The problems which confront the designing engineer were considered. Quality must sometimes be subordinated to expense, and first cost balanced against operating efficiency. The extent of standardization of parts requires careful consideration, and the proportioning of outside dimensions and quality of exterior finish depend entirely on local conditions. Reactance drop and temperature specifications

for transformers were considered, and the effect of high flux density under over-voltage. The engineering and commercial conditions are vitally related.

The discussion was opened by C. P. Steinmetz, who called attention to the great progress which has been made in the use of high voltages and of the changes made necessary in the Standardization Rules of the Institute on account of the increase in our knowledge of the subject. He thought that this paper should be referred to the Standardization Committee for further study of the subject, as the present specifications leave a great deal unexplained. One of the important questions raised in the paper is in regard to the spark gap, which is the only correct method of measuring disruptive strength. The great difficulty is in securing standard conditions for experiment. At the time the spark gap was standardized we had no knowledge of the effect of transient voltages or the time of application of voltage. A voltmeter measured the effective value of voltage and not the disruptive strength. To know the latter we must also know the wave shape. The wave shape at the generator is generally a sine for modern alternating-current machines, but the wave shape at the point of test may be greatly distorted.

A. H. Pikler spoke of the use of liquids and solids in the design of insulation of machinery. He considered fibrous insulating materials should not be relied upon in designing, but should be considered only as a binder for the liquid materials which really do the work. The most important thing in the design of insulation is a mechanical disposition of the various parts which should be constructed with smooth surfaces and without sharp corners. Then the water should be expelled and an insulating compound introduced which may be depended upon for the insulation. He differed with the author as to the use of an auxiliary wiring on the transformer in preference to the spark gap for a direct measurement of voltage, since it was the potential difference at the point of test and not at the transformer which is wanted. He also differed as to the best type of transformer for voltage testing. Referring to the paper by Mr. Wooldridge he thought the method of work and the shape of the test pieces should be given before much weight could be attached to the results. Regarding the design of transformers he thought that the most economical design and simplest construction frequently went together, and that lavish use of material resulting in high cost was not synonymous with the best efficiency.

Ralph D. Mershon considered the use of an auxiliary coil in the transformer as a correct method of measuring the voltage and referred to his use of this method in his high-voltage measurements at Telluride and Niagara.

William L. Puffer considered the most accurate method of measuring the voltage to be the use of an exploring coil on the transformer with a static voltmeter.

A motion was then made and carried that the Board of Directors be directed to refer the paper by Mr. Hendricks to the Committee on Standardization.

A. S. McAllister criticized the method of separating the two components of losses and asked for some explanation of the variation of eddy-current loss with flux density.

L. T. Robinson substantiated the results obtained in the hysteresis tests as they agreed with those obtained by the ballistic galvanometer. He thought that we needed further theoretical analysis of the conditions which determined eddy-current loss. The eddy losses in similar transformers with cores of different materials do not give the relative values which are to be expected from the resistance of the core material.

George F. Sever spoke of the methods of measuring breakdown voltage, size of test plates, etc., and termed the whole situation as very chaotic. The methods of test used do not give consistent results, but perhaps the work of Mr. Hendricks will result in a uniform method which will give consistent results. He thought perhaps the use of condensers in series would give good results in the measurement of high voltage, but he asked the author as to the status of this method.

J. R. Craighead questioned whether the electrical constants determined in the laboratory were applicable in practical work. For instance, in testing large cables in actual installations it is not always possible to get a sine wave. The control of the apparatus brings in another difficulty, and the available voltages are limited. He considered the spark gap the most reliable method for measuring voltage even though it is not perfect. He considered the use of a potential transformer at the point of test superior to a volt coil on the step-up transformer.

J. L. R. Hayden stated that the variation of the hysteresis exponent with flux density was not new, but he considered the variation of eddy-current loss as questionable. The eddy-current losses in silicon steel usually are a small part of the total, and their determination is probably inaccurate.

F. M. Farmer regarded the electrostatic voltmeter satisfactory for voltages up to 50,000 volts. The size of the electrode has a great effect on electric strength of fine material such as cloth and paper. The capacity of the testing outfit may cause wave distortion, which alters the apparent puncturing value where large electrodes are used. With small specimens this does not enter.

H. L. Schermerhorn referred to the small size of electrodes used by the author and questioned the use of the constants determined in practical work. He considered the standardization of areas by the Institute as very important.

E. M. Hewlett referred to the need for a quick test in practical factory work and regarded the spark gap as the most convenient. He thought the spark gap should be calibrated up to about 700,000 volts. In testing the liquids there was a great difference according to the time of the test. It also depended upon the bulk of material used.

W. J. Foster referred to the wave shapes of the different machines used and the best design for securing sine wave.

Charles F. Scott stated that the Standardization Rules were not to be regarded as either an oracle of an encyclopedia and cannot be expected to cover everything. He spoke of the many diffifficulties in drawing up rules which should apply equally well in all cases.

Brief remarks were also made by C. A. Adams and E. W. Rice.

At the close of the session the members were invited to inspect a short section of 200,000-volt transmission line at the General Electric Company's works and see the corona effects.

EVENING SESSION.

President D. C. Jackson called the evening session to order and occupied the chair. After an announcement by the secretary, a paper on "Design, Construction and Tests of An Artificial Transmission Line" was presented by J. H. Cunningham.

ARTIFICIAL TRANSMISSION LINE.

Mr. Cunningham's paper describes the design and construction of an artificial transmission line that was built in the electrical laboratory of Union College to reproduce the conditions of a high-voltage long-distance line. The design selected consisted in winding wire on glass cylinders or tubes that were lined with tinfoil. The cylinders are six inches in diameter, 4.5 feet long and one-eighth of an inch thick. They are each wound with 240 turns of No. 8 B. & S. copper wire. The resistance of each is 0.24 ohm at twenty degrees centigrade; the inductance is 1.04 millihenry; the capacity 0.00748 microfarad. Each cylinder is the equivalent of one-half mile of No. 00 wire spaced five to six feet apart. Four hundred cylinders have been built and mounted on four racks. The completed line has the following constants: resistance 93.6 ohms; inductance 0.3944 henry; capacity 1.135 microfarad. The line was intended particularly for the study of transient and other phenomena in connection with switching, sudden changes of load, etc. The oscillographic results of some of the tests already conducted are given in the paper.

Tests were also conducted on the line between Denver and Boulder. In all the tests no perceptible effect was discovered from change of humidity. The author, in conclusion, points to the fact that while these high no-load corona losses are of greater theoretical than commercial interest, they point nevertheless to prohibitive line loss if the operating voltage is much further increased above its present commercial limit.

This was followed by a paper on "Protection of Electrical Transmission Lines," by E. E. F. Creighton.

R. H. Marvin then presented a paper on "Tests of Grounded Phase Protector on the 44,000-Volt System of the Southern Power Company," by himself and C. I. Burkholder.

The final paper of the session was by G. Faccioli and was entitled:

TESTS OF LOSSES ON HIGH-TENSION LINES.

In Mr. Faccioli's paper are given the results of some tests on the three-phase transmission line of the Central Colorado Power Company to determine the line losses on no-load. This was done by direct measurement with wattmeters at the generating end, chiefly the Shoshone power house. The length of line from that point to Denver is 153.5 miles; from another plant at Boulder there is a line to Denver 27.6 miles in length. The lines run at very high altitude, the highest points being 13,700 feet. By field variation of the generator the impressed voltage was raised to about 105,000 and wattmeter readings taken at various voltages. The line voltage was found to be about ten per cent higher at Denver than at the Shoshone power house. The loss with 100 kilovolts at the source was about 1,000 kilowatts with the line open; with the line loaded the line loss dropped to relatively small values. To prove the probability of the no-load loss being by far greatest near the open end of the line, due to its increased voltage and therefore much greater corona formation, the line was opened at the Leadville substation, 63.5 miles from Shoshone and the following confirmatory results obtained:

	Kilowatts Loss.		
Kilovolts at Shoshone.	Shoshone to Denver.	Shoshone to Leadville.	Difference.
80	109	10.6	98.4
90	341	37.9	303.1
100	1003	152	851

The four papers were discussed together, the discussion being opened by Ralph D. Mershon. He asked a number of questions regarding Mr. Faccioli's paper and criticized the method of obtaining the critical voltage. He discussed the importance of the vapor product. He also announced the perfection of an insulator which could withstand strokes of lightning and power arcs.

Charles S. Ruffner said that line losses consumed only 7 per cent of the energy generated. The losses on open circuit are probably greater than those when transmitting power, on account of wave distortion. Merely connecting transformers to the open ends of the line will greatly reduce the losses.

L. C. Nicholson spoke of the three things that affect the transmission line, direct strokes, flashovers and interference. The direct stroke can be solved by the insulator. Flashovers continue to occur, but do no damage, except that they are inconvenient while they are occurring. That depends on setting the relay. It has depended on that up to the last lightning season, when on the main lines of the Niagara Falls, Lockport and Ontario Power Company, loaded with 80,000-horsepower, insulator breakage has been practically obviated. The number of insulators broken per line in the last two years has been about two per cent, so that insulator breakage has been reduced to a point where we can take care of it without any inconvenience. However, flashovers still continue. This grounded phase protector is a duplication, to some extent, of what he has been employing to get rid of the arcs at the insulators. Allow a ground to stay on the line fifteen seconds and it will either clear itself or develop into a short-circuit without doing any damage otherwise. So that the problem which presented itself was to rid the system of short-circuits and do it quickly enough to save the synchronous load. The receiving apparatus is synchronous, 25-cycle synchronous rotary converters or synchronous motors of large size, almost entirely. The solution presented itself of short circuiting the lines which were already short-circuited, putting on another short-circuit, and one which will rapidly disappear after it goes on, and by that means shunting the primary short-circuit with a short-circuit at the station. This has been done by means of an inclosed fuse tube about six feet long, made out of a combination of paper, mica, etc., fitted with copper wire about No. 16 B. & S. gauge. One of these tubes is attached to each bus and connected to air switches which cut in as near instantaneously as possible. The separation of the air gap is ten inches, a safe striking distance for 50,000 volts. It is worked by a spring lever, with a pressure of about 40 pounds, and falls in in two cycles or 0.08 second.

Taylor Reed spoke of the remarkable serviceability of the oscillograph under field conditions and how much had been accomplished with it under adverse circumstances.

J. L. R. Hayden referred to the industrial importance of the time lag in the dielectric spark and the arc, owing to the enormous transient voltage required to break down even a short gap. Experiments with mercury-arc rectifiers indicated that 0.001 second overlap was sufficient to keep the arc from dying out between reversals, and the time was even shorter with large currents and short arcs. Minute traces of residual gases greatly retarded the formation of the arc. Three oscillograms were shown for alternating arcs between carbon and titanium terminals which indicated that the minimum voltage occurred later than the maximum current.

F. W. Peek, Jr., said that humidity affects the critical voltage very little, except during actual rain or snow storms, when the corona loss is increased. He also discussed the method of measuring the power loss.

L. T. Robinson protested against the use of redrawn oscillograms, since it is easy to get exact reproductions of the original records. The data from which curves are drawn should also be given.

H. T. Plumb referred to some early experiments on an experimental transmission line.

C. F. Scott spoke of the importance of the papers which had been presented and especially complimented Prof. Creighton.

PITTSFIELD SESSION.

The third session of the convention was held on Wednesday afternoon, February 15, at Pittsfield, with President Jackson in the chair. The first paper by C. P. Steinmetz was entitled:

MECHANICAL FORCES IN MAGNETIC FIELDS.

In large apparatus the mechanical forces due to magnetic fields may assume formidable values on the occurrence of short circuits or other abnormal conditions so as to tear the apparatus to pieces, if sufficient strength has not been provided to prevent this. Dr. Steinmetz has, therefore, made a study of such forces and developed a more rational, simpler and more accurate method of calculating them. This also gives a better design of electromagnets and permits calculating their efficiency. This method uses the law of the conservation of energy to relate the different forms of energy involved. Taking up the constant-curret magnet, Dr. Steinmetz finds that for an average pull of one pound over a distance of one inch, at least 8.6 volt-amperes are required at sixty cycles and at least 3.6 volt-amperes at twenty-five cycles. He also develops formulas and works out typical problems for the constant-potential alternating magnet, short-circuit stresses in transformers and repulsion between conductors. Respecting transformers he finds that the short-circuit stresses are inversely proportional to the leakage reactance of the transformers and that therefore the latter should be large. The repulsion between a cable conductor and its adjoining return conductor may be great enough to lift the cables and throw them aside. The paper concludes with some general equations of mechanical forces in magnetic fields.

The discussion was opened by A. S. McAllister, who called attention to the fact that the energy made available by the motion was not a difference of the potential energies, but the energies of condition. Since with iron in the circuit the energy in the magnetic field cannot be easily specified, the application of the equations is hard in such cases.

G. Faccioli discussed the mechanical forces which act on transformers under short-circuit conditions. The problem of the design was to keep the windings in place under such circumstances. This is accomplished by adopting a strong mechanical construction and in certain cases by distributing the leakage flux uniformly over the leakage path. The magnitude of the forces may be decreased by increasing the reactance and especially by inserting a reactance outside the transformer. In large power transformers the ability to withstand short circuits is far more important than good regulation.

C. M. Davis discussed the operation of solenoids especially with respect to those used with oil switches. He showed that the maximum efficiency of such a solenoid is fifty per cent.

Frank C. Green related some experiences in the bending of transformer coils due to short-circuit and showed that there is a force tending to shove one coil up with respect to the other.

C. J. Barrow discussed the stresses existing between two parallel conductors, with special reference to busbars. He showed that with the actual distribution of currents among several laminations the theoretical value was not reached.

A. H. Pikler called attention to the reason why transformers sometimes fail nowadays on short-circuiting, but did not do so formerly. The mechanical construction has not kept pace with the advance in insulating material which permitted the conductors to be brought closer together, at the same time diminishing the reactance. The importance of reactance has been appreciated for some time. He doubted whether the proposed calculation of the forces would apply to actual conditions. The forces which apply in practice are not due to currents which are gradually brought up to a short-circuit value, but depend upon quick application and upon the magnetic conditions found in the core at that moment.

John J. Frank supplemented the remarks of Mr. Pikler and stated that it was not a single short-circuit usually, but a repetition of that condition which breaks down the transformer.

Charles F. Scott stated the trouble is often not with the transformer, but with the power plant, and cited cases in his experience where the transformers behaved well for many years, but broke down when more generating capacity was added to the system.

H. C. Cox stated that in testing transformers five times the normal current was used and only one transformer has ever broken down under these conditions.

V. Karapetoff sent in a written communication citing many references to the literature of the subject under discussion and showing that much of the work in the present article was to be found in other sources. He referred particularly to the work of Emde, Jasse, Underhill, Thompson and Ampère. Russell's treatment of the relation connecting the force between transformer windings and the magnetic leakage is more correct than that given by the author. He advocated the more general reference in the Institute Transactions to the previous work of others and gave a number of good reasons to support his point.

K. Faye-Hansen also contributed a written discussion in which was pointed out a numerical error which had been carried through almost the entire work of the paper. He showed that the short-circuit stresses computed by the author were too low on account of one of the assumptions made and gave his own derivation for this expression. The forces which had been computed were for the final value of the short-circuit current. In the first few cycles of short-circuit, however, the current may have twice its final value and the forces be consequently twice as great as given by the formula. On account of the effect of the distance between the coils the forces really alter faster than in inverse proportion to the leakage reactance.

J. M. Weed worked out results of the same problem from another standpoint.

Written discussion was also contributed by H. B. Dwight, E. Jasse and G. Alexander.

C. E. Allen then presented a paper entitled:

THE REGULATION OF DISTRIBUTING TRANSFORMERS.

Mr. Allen's paper states that the use of silicon steel has placed great stress on the low iron losses thereby attainable, but has detracted largely from consideration of the exciting current and regulation. The regulation of the average distributing transformers now on the market varies from one to 3.5 per cent and even up to four per cent on power factors as low as 0.6. Considerable discrepancy exists as to the approved method of calculating regulation; this should be standardized. It is usually impractical to obtain transformers with the best regulation unless some other characteristic is sacrificed. Therefore each feature should be considered in a well-balanced design, and all characteristics made equally good. Mr. Allen shows how the distributed shell-type transformer has its regulation improved by careful interlacing of its coils. In the core type this is obtained by long cylindrical coils without interlacing.

This was followed by a paper entitled: "Temperature Gradient in Oil-Immersed Transformers," by James M. Weed.

THE TEMPERATURE GRADIENT IN TRANSFORMERS.

Mr. Weed points out at the beginning of his paper the objections to high temperature in transformers. These are: deterioration of the insulation at high temperatures, increase in copper losses, tendency to deposit solid hydrocarbons from the oil, aging of the iron and increase of core loss. A knowledge of the distribution of temperature is therefore desirable. Mr. Weed therefore undertakes a study of the various steps in the cooling process based on the known laws of heat transfer. He recognizes seven steps in this process, and analyzes

each in some detail. Heat is carried from the coils to the external cooling medium by conduction, convection and radiation, the relative amounts due to these agencies varying with the design of the transformer. Various types of transformers are considered, but principally the self-cooled oil-insulated type. The principal features in the cooling action are the oil and the tank surface. Much care must be given to the design of the oil passages, to the selection of non-viscous oil, and to the form of the outer surface. More than half the heat thrown out from a plain tank is by radiation. Corrugation of the surface increases the convection only. Corrugations, if used, should be wide and deep. Further study is needed to increase the rapidity and thoroughness of heat removal from transformers if the present limit of capacity is to be raised.

This was followed by a paper, "Dissipation of Heat From Self-Cooled, Oil-Filled Transformer Tanks," by J. J. Frank and H. O. Stephens. Mr. Stephens presented the paper.

The last paper of the session was by F. C. Green, and was entitled:

PROBLEMS IN THE OPERATION OF TRANSFORMERS.

Mr. Green's paper concerns itself principally with practical details to be observed in the installation and operation of transformer failures are from abnormal voltage given to such details because they mean insurance against breakdown with its need for disconnecting the transformer and repairing it on the spot. As a rule, transformers and their oil must be shipped separately, which necessitates artificial drying of both the oil and coils to drive out any moisture absorbed. Almost all transformer failures are from abnormal voltage conditions, particularly disturbances of the voltage equilibrium within the windings; in other words, the most common punctures occur between turns of the same coil. The portions of the windings most exposed to excess potentials are near the line ends; these should be protected by extra insulation. The microfarad capacity of the transformer should be small. Line disturbances should be reduced to a minimum. Reactances should be put in circuit with transformers having low inherent reactance. In operating great care must be given to see that the transformers are properly cooled at all times; if many self-cooled transformers stand in the same room the latter must be thoroughly ventilated. The utmost care must be given to insuring that transformers are properly connected, and Mr. Green devotes much space to diagrams and discussion of a number of connections that are baffling to the operator.

The discussion of these papers was opened by W. S. Moody, who spoke of the arbitrary and empirical elements in transformer design. The trouble in the past has not been that proper mechanical support could not be provided, but it was not provided because the values of the forces involved were unknown. Now that we know how to compute these forces there is no trouble in securing sufficient strength.

A. H. Pikler discussed the relation of resistance and reactance to the regulation of the transformers. Regarding the installation of transformers, which often break down on the customer's premises, although tested out at the factory, he advocated rules requiring testing at the point of installation by the manufacturer. Other conditions such as surges on closing the line are encountered in practical installations which do not obtain at the factory trials of transformers. Mr. Green's suggestion that the electrostatic capacity of the parts of the transformer should be small is very important. He did not agree that low regulation in large transformers was due so much to the customer's requirements as to the inherent nature of the problem. A high-reactance transformer means an expensive transformer, since more ampere-turns are required, hence more copper, more winding space and more iron. A proper compromise has to be made between mechanical construction and increased reactance. Another effect of increasing the ampere-turns is to increase the eddy currents. In regard to the cooling of transformers the upper part of the surface comprises almost the entire useful area, and an effort should be made to make this area uniform in efficiency. European designers are far ahead of us in making self-cooling transformers up to capacities of 3,000 kilowatts. One reason for this was that the European standard for rise of temperature is twenty or twenty-five degrees higher than the American. He considered sixty degrees of temperature rise perfectly safe.

E. G. Reed called attention to the fact that self-cooled transformers for 3,000 kilowatts are being built in this country today, using the external tubes.

L. F. Blume discussed the formulas for regulation. With the present definition of regulation, magnetizing current should not enter the formula.

E. A. Wagner recommended that the Institute adopt a definite formula for regulation. His experience with self-cooling transformer tanks agreed with Messrs. Frank and Stephens that fifty per cent less watts were dissipated with a corrugated-sheet-steel tank than with a cast-iron tank. Deep and narrow slots are likely to produce air pockets. He had found the use of marine tubes to give an advantage of only one or two degrees, which is not enough to warrant the additional complications.

C. A. Adams was favorably impressed by the tendency shown by the designers toward a more accurate and scientific analysis of the problems involved. Experiments on the conduction of heat are difficult, but very important. He also described the effect of the third harmonic in transformer operation.

A. E. Waldon contributed a written discussion of Mr. Allen's paper. He stated that actual tests of transformers usually give better regulation than that claimed by manufacturers. He discussed the effect of regulation on the loss in feeders, especially in circuits with low power-factors, such as are found with induction motors, which sometimes constitute the largest part of a day load.

R. D. Mershon asked a number of questions of the authors. C. W. Stone called attention to some of the important points in the papers and emphasized particularly that the best type of lightning arrester will not give protection to the transformer and that all breakdowns do not represent defects in the transformers. He advocated exterior reactance. He did not regard close regulation as a very important requirement in these days of high diversity-factor.

E. J. Berg gave a convenient formula for estimating the heat that can be radiated through holes in the punchings. In case of overloading, the temperature gradient in the insulating material loses its proportionality to the gradient under normal conditions.

H. O. Stephens discussed the temperature relations in the transformer and stated that the effect of increasing the number of corrugations in the tank is more effective than the formula given by Mr. Weed would indicate, as he pointed out that all of the assumptions made in deriving the formulas do not apply.

C. P. Steinmetz spoke of the undesirability of the high-tension switch. The value of reactance is not particularly for high-voltage lines, but the drop on such lines would usually of itself limit the short-circuit current at the transformer. High reactance at the transformer is therefore not essential. It is in systems of almost unlimited power with negligible drop that it is needed. Iron-plate reactive coils should not be used.

A report of the final session at Schenectady will be given in our next issue.

CENTRAL-STATION PRACTICE

Transmission—Interior Wiring

ELEMENTS OF POWER-STATION DESIGN.—XXIV.

STORAGE-BATTERY PLANTS.—II.

BY W. B. GUMP.

If a gas engine is used instead of steam, the boilers are at once eliminated, and the cost of operation could be further reduced. This arrangement would apply more particularly to the plant of a country residence. The question immediately presents itself as to whether exhaust steam for heating is the main object of the plant, and the electric power a by-product, or vice versa, whether the electric power is the first consideration, and steam heat an unimportant item. It is evident that in the steam-engine plant the building could not be heated by means of exhaust steam, except when the engine is operating. During other periods the heating would have to be done by live steam at reduced pressure. This would require an attendant at night, and would increase the operation, both in fuel and cost of attendance, annihilating the economy first mentioned. The case of a country residence is apt to be such that practically no steam heat would be required after the late evening hours, and this would give all generating apparatus a rest until the following morning.

FIG. 2.—END CELLS.

The factors entering into the economics of isolated plants are so deep-seated that their analysis cannot be embraced in this limited space. The foregoing case has been given with the idea that it strikes a general average of isolated lighting conditions. Local conditions of the particular plant in question will determine the feasibility of a battery equipment.

(*c*) *Floating Batteries.*—As generally considered, a "floating" battery is one which is simply connected across the line and remains continuously in parallel with the generators. This arrangement is only applied to fluctuating loads where the voltage variation is considerable. Examples of this nature are not uncommon in electric railway work, as for example, at or near the end of a line where it is important to prevent too great a drop, and at the same time desirable to effect a saving in copper. It is evident that, in order to discharge the battery, the line voltage at the place where the battery is connected must fall below that of the battery. When the line voltage rises the battery begins to charge. Thus, the battery is kept charging and discharging, according to the voltage variation due to the load.

A floating battery placed near the end of a line will in many instances save a large amount of copper, on account of boosting the voltage at the point fed by the battery, and thereby doing away with feeders extending all the way from the generating station.

It must be remembered that a storage battery is costly, and requires care in handling. Therefore, it is necessary in considering the feasibility of a battery operating under the above conditions, to compare its cost and operating charges to those of a series booster, located at the power station; adding, of course, the cost of the feeders.

(*d*) *Battery Operation Without Boosters.*—The simplest method of charging a storage battery without a booster is by varying the generator voltage; this method may be used in cases where it is not required to supply a load at constant voltage direct from the generator. The discharge voltage of the battery is regulated by a set of so-called "end cells," (See Fig. 2), whose number is determined as follows:

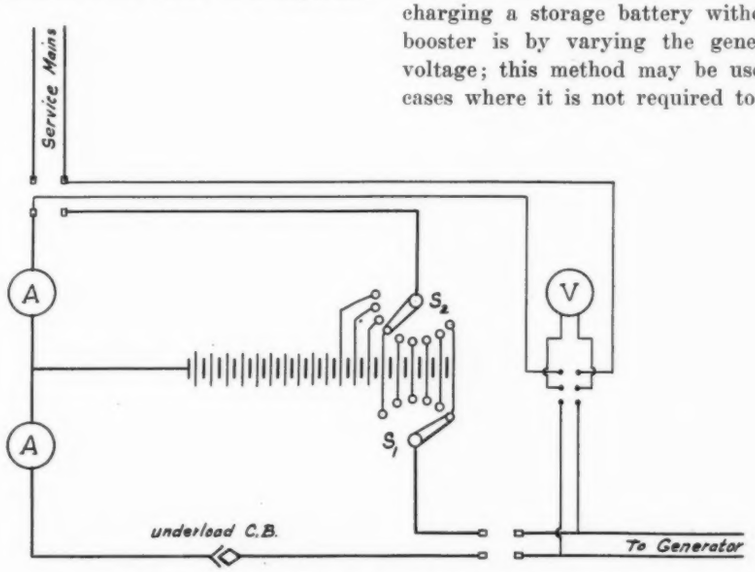


FIG. 3.—ARRANGEMENT OF TWO END-CELL SWITCHES.

For example, consider a lighting system having a potential of 110 volts. The total number of cells required will be $110 \div 1.8 = 62$ cells in circuit at end of discharge. At the beginning of discharge the number of cells in circuit will be $110 \div 2 = 55$ cells. Thus

a total of at least seven end cells is needed.

When the battery is fully charged, the generator voltage required will be $62 \times 2.6 = 161$ volts. The minimum generator potential is $62 \times 2 = 124$ volts, at beginning of charge.

It will be seen that the end cells are unequally charged, and that the last cell (the end one) requires the least amount of charging. The next requirs a little more, the third a still greater amount, so that from the first to the last there is a gradient which theoretically tapers off to zero at the last cell. This condition shows that the required capacities of the end cells are unequal, each cell requiring a capacity according to its location from the end. It is evident, therefore, that the sizes would vary accordingly, if they were designed for a fixed position. In practice, however, it is a great advantage to interchange the cells, and avoid special sizes. For this reason the cells are preferably all one size.

Where it is required to use a constant-potential generator for charging the battery, and at the same time supply lighting service at a lower potential, two end-cell switches are sometimes used. Such a system is shown in detail in Fig. 3, in which we shall assume that the service system is 110 volts, requiring sixty-two cells, as previously computed. The generator voltage necessary to charge the battery is 160 volts.

An inspection of the diagram will show that as charging proceeds the contact arm on end-cell switch No. 1 will be moved to the left, step by step until the battery becomes fully charged, when all of the end-cell contacts on the lower side are cut out of the generator circuit. The relation between the two contact arms must be kept such as to maintain a constant difference of potential. It was made clear in the preceding example, that seven end cells were required. In considering the number in the present example it must be noted, first of all, that the cells toward the end are not fully charged, and are never fully discharged, the actual amount of energy diminishing toward zero at the last call, as formerly pointed out. If the minimum charging voltage is 2.2 volts per cell, the total voltage for sixty-two cells is $62 \times 2.2 = 136.4$ volts; that is, the last cell will require 2.2 volts at the beginning of charge, the next to the last will require a somewhat higher voltage, for a different length of time, and so on, until all the cells reach a charging potential of 2.6 volts per cell.

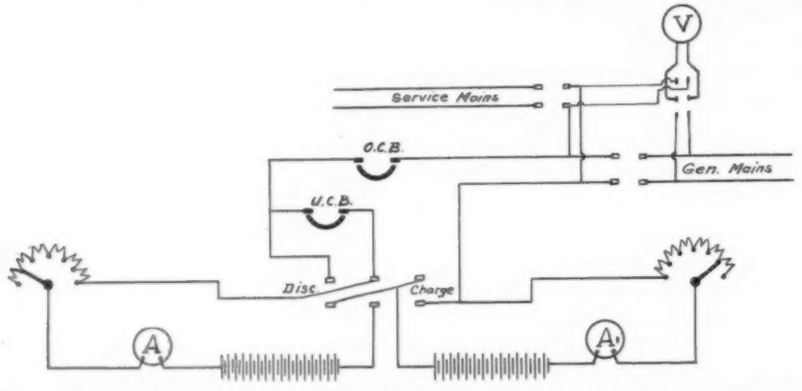


FIG. 4.—CHARGING TWO GROUPS OF STORAGE CELLS IN PARALLEL AND DISCHARGING IN SERIES.

If the generator voltage is constant there would finally be $136 \div 2.6 = 52$ cells in circuit, or by calculation ten end-cell contacts on switch No. 1.

There must be a difference of $136 - 110 = 26$ volts between the two arms. As charging advances, the final value of the voltage per cell should average close to 2.6 volts. Then the number of end-cells interposed between arms is $26 \div 2.6 = 10$ end cells. Now since twenty-six volts is a constant between the two arms until charging is completed, it is evident that the ten cells above computed must be added to the ten cells, of switch No. 1, or there will be needed twenty cells available for switch No. 2.

It will be seen, moreover, that the end cells between the two contact arms each require a current capacity for charging, plus the current of the load. They must, therefore, be larger than those of the main battery. This is a disadvantage, of course, both on account of the lack of interchangeability and the increased cost of higher capacity cells, which, in the case just given, compose one-third of the battery.

Counter E. M. F. Cells.—Instead of using end cells in the main battery, an arrangement of cells known as counter electromotive force cells has been employed. These cells counteract, or "buck" the main line cells, instead of adding to them. In construction, such cells are simply lead plates, which have not been provided with more than a film of active material and which merely act to give a difference of potential.

There are several serious objections which have prevented the extensive use of counter e. m. f. cells. In the first place, the installation of counter e. m. f. cells demands these, in addition to the maximum number of cells in the main battery, contrary to the usual end-cell arrangement. Another serious disadvantage is that these cells are

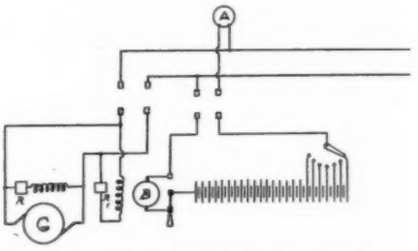


FIG. 5.—CONNECTIONS FOR SHUNT BOOSTER.

special, and being for potential only, they cannot be interchanged with the main battery cells. Present practice is abandoning the use of counter e. m. f. cells. Their only advantage is that the cells of the main battery are equally charged and discharged. The cost of the additional equipment, however, is not ordinarily justified for the small advantage to be gained.

Construction of End-Cell Switches.—A great many forms of end-cell switch have been employed, both automatic and hand-operated. In order to prevent breaking the circuit, the contact blade must span the gap between adjoining contacts. The chief feature of an end-cell switch which makes it troublesome is that the contact blade is liable to remain across two adjoining contacts of the cell terminals, thus short-circuiting one of the cells. This occurs momentarily as the contact arm is being

moved across the switch contacts. The only practical method of preventing a dead short-circuit is by mounting alongside the main contact blade an auxiliary blade electrically connected to it through a resistance. Automatic end-cell switches are generally constructed so as to compel the arm to stop on a single contact and prevent it from remaining across two terminals. In this way the short-circuit (through the resistance) is but momentary.

Fig. 4 shows an arrangement for charging in parallel and discharging in series. Here the two rheostats regulate the charging currents. This system may be used where space is limited and does not permit the installation of a booster.

(*e*) *Battery Operation With Boosters.*—There are so many methods of operating boosters in connection with storage batteries that only a few of the commoner systems will be described. In each case the purpose of a certain type will be explained, showing the operating conditions for which such a type should be installed.

For a simple lighting or power load, particularly where the load is not large, and the fluctuations are slight a shunt booster is commonly used. This is for charging only. At the end of the charge it is cut out of service. The details of operation may be understood from Fig. 5, in which *G* is the main generator. This carries the load when the battery is not operating, or, if of sufficient capacity, the generator may take the load and charge the battery simultaneously.

Non-reversible Booster.—The booster just described was for charging only, and is, of course, non-automatic in its action. The so-called non-reversible booster, to be described, is a form of automatic booster adapted to conditions where both a constant and a fluctuating load are to be supplied by the same generator, or group of generators. Conditions of this sort obtain in the case of hotels, office buildings and apartments, where elevator service and lighting are both supplied.

Separate sets of busbars are employed; one for the lighting, and the other for the power service, such as elevators. The lighting bus is connected straight to the generator, while the power bus is in parallel with the battery and has the booster in series. Observing Fig. 6, it will be seen that the booster has two field coils. Since the load on the generator is to be approximately constant, the current in the series coil will also be nearly constant. The series field tends to oppose the generator voltage. The shunt coil is connected so as to oppose the series field, and practically always overpowers it.

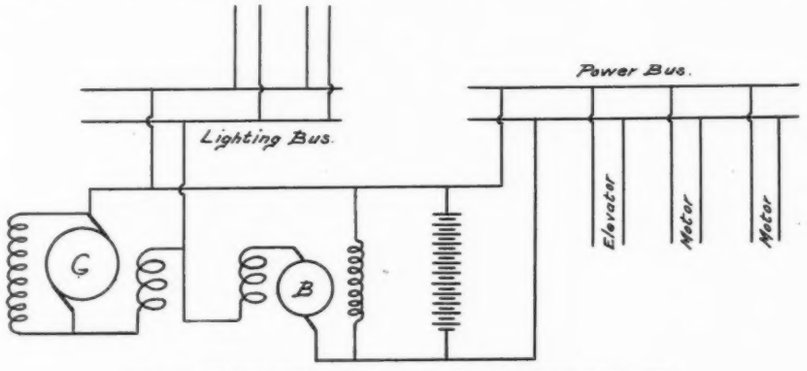


FIG. 6.—CONNECTIONS FOR NON-REVERSIBLE BOOSTER.

This causes a higher potential between the battery terminals than exists across the lighting bus, by an amount equal to the booster voltage, which normally is about fifteen volts.

The principle of the action is as follows: When normal current flows through the booster, the battery is neither charged nor discharged and the power load is carried entirely by the generator. A heavy load on the power busbars causes an increase in current in the series coil of the booster, strengthening the series field and lowering the booster voltage. This produces a drop across the power bus, causing the battery to discharge. The battery will, therefore, take all of the current demanded by the power load over and above a practically fixed current on the generator bus. When the power load is somewhat less than normal, the opposing series field is weakened, the resultant field, therefore, strengthened and the booster voltage increased so as to charge the battery. The booster field is partly differential in its action, but the booster proper, as its name implies, is non-reversible in that its armature current is always in one direction.

Reversible or Differential Booster.—The diagram Fig. 7 serves to show the operation of a reversible or differential booster. Here it will be noted that the battery is in series with the armature of the booster. The booster has two field coils, as in the former case; a shunt, and a series field. These fields are so related that normally, that is, with normal generator current, there is no field produced, and hence no potential furnished by the booster in either direction. Therefore, the battery is neither charging or discharging.

Should the power load increase, the series-field current will increase, overpowering the shunt field, producing current in the booster in a direction which will cause the battery to discharge. If the load current falls below the normal average value, the shunt coil predominates, causing the battery to charge.

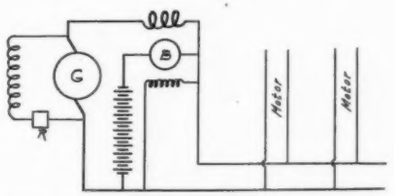


FIG. 7.—CONNECTIONS FOR REVERSIBLE BOOSTER.

It will be seen that the load on the generator is not absolutely constant, but fluctuates with the power load. However, at times of light load the battery is charged and at heavy load it discharges, thus smoothing out the generator load curve. This form of booster is more suited to railway work, while the non-reversible booster is better adapted to hotels, department store, and office-building plants.

(*To be continued.*)

[EDITOR'S NOTE.—This important series of articles was started in the ELECTRICAL REVIEW AND WESTERN ELECTRICIAN, Sept. 3, 1910, and before its conclusion will cover every phase of central-station design.]

The Brooklyn Automobile Show was held from January 15 to 25 at the Twenty-third Regiment Armory in Brooklyn, N. Y.

ELECTRIC LIGHTING and ILLUMINATING ENGINEERING

THE FLAME ARC HOLDS THE TRADE.

BY H. THURSTON OWENS.

The flaming arc lamp is now beginning to receive some of the attention which it merits as a medium of attracting the public and bringing business.

The great majority of the installations have been in the form of bracket lamps upon buildings similar to that shown in Figs. 3 and 4 and the striking contrast between the great flux of light from these new lamps and the glass globes inclosing incandescents over the doorway indicate the rapid advances which we are making in the use of light, especially upon the main streets of our cities.

This installation is on Broadway between Twenty-ninth and Thirtieth Streets, New York City, a district which is beginning to wane in comparison with that portion of the street half a mile north and these lamps have gone far to keep the district a popular one.

When posts are used, as in Figs. 1 and 2, the lighting becomes still more effective, as the double service is obtained of better lighting on the sidewalk and street, and the lamps may be seen from a much greater distance.

In this block above mentioned there are no less than twenty flame lamps within 200 feet, to say nothing of the sign and window lighting, so that the reason for this portion of the street being popular is at once apparent.

If we go north a half mile to Broadway and Thirty-ninth Street, we find the new restaurant, shown in Figs. 1 and 2, which, while not suffering from a poor location, has made itself conspicuous by the six flame lamps and an electric sign, as well as by the "real German cooking" which it offers. The iron frame-work of another of those monster signs which has made possible Broadway's title of the "Great White Way" may be seen upon the roof of one of the buildings.

Making a neighborhood might be termed as the reason for the lighting shown in Fig. 5. It is located at Broadway and Forty-ninth Street, quite out of the "high life" district, being in fact the northern outpost for the seekers of late suppers.

The installation shown in Fig. 6 is at Seventh Avenue and One Hundred and Twenty-fourth Street, and the sign in this case would be effective upon the best lighted residence street in New York, and at least the equal of any in the country.

FIG. 1.—FLAMING ARCS ON POLES.

FIG. 2.—THE "GREAT WHITE WAY."

Both post and building lamps are metered and all of those illustrated are supplied from the mains of the Edison and the United Companies, through whose courtesy the photographs are reproduced.

Lighting and Heating Plant of the Department of the Interior.

The heating, lighting and power system of the Department of the Interior, Washington, D. C., is increasing to a considerable size, and one more street has now been torn up in order that further extensions may be made and more buildings served.

The heating and lighting plant of the Department is located in the old Post Office building, between E and F Streets and consists of three boilers of 200 horsepower each and two of 250 horsepower each. The engines and dynamos comprise four units—two of 100 kilowatts each, one of seventy-five kilowatts, and one of fifty kilowatts. These boilers and generators are used both for heating and lighting, and from this plant at the present time heat is supplied to the old Post Office Building, Patent Office Building, Bureau of Mines, Pension Office and the Civil Service Commission Building, while electric power and light are furnished to all the above mentioned buildings except the Court of Appeals and the United States Courthouse, both of which are now served by the Potomac Electric Power Company. It is now the intention to connect these two buildings up with the main plant, and to install a new 250-kilowatt generator, as the present plant is being worked to its fullest capacity.

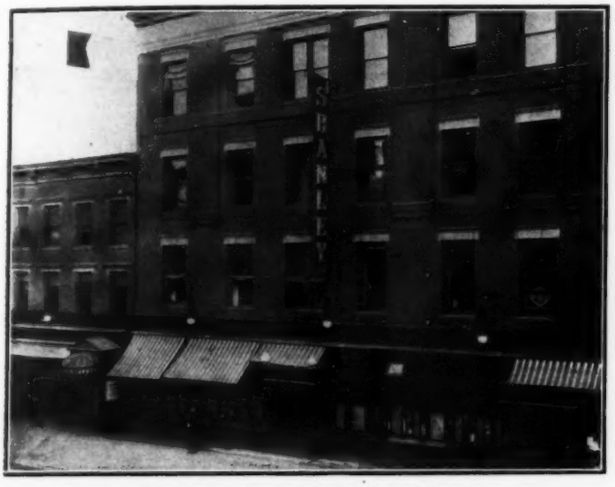


FIG. 3.—FLAMING ARCS ON BRACKETS.

FIG. 4.—NIGHT ILLUMINATION.

FIG. 5.—BROADWAY AND FORTY-NINTH STREET.

FIG. 6.—AN UP-TOWN INSTALLATION.

A compass which graphically records the deviations that a ship makes from her course has been invented by a Rhode Island pilot.

World's Production of Tungsten.

The world's production of tungsten for the year 1909 was 5,289 short tons of concentrates containing about sixty per cent of tungsten trioxide. This figure is larger by 1,391 tons than the production for 1908, according to Government statistics.

The principal sources of the 1909 production were: United States, 1,619 tons; Argentina, 900 tons; Australia, 1,200 tons; Bolivia, 168 tons; Germany, 106 tons; Portugal, 609 tons, and the United Kingdom, 421 tons. The value of the tungsten ore produced in the United States during 1909 was $614,370, compared with $229,955 in 1908 and $890,048 in 1907. With the recovery of the American steel trade during 1909 prices rose above those of 1908 and ranged from $5.00 to $9.00 per unit for tungsten ores, the average price being from $6.00 to $6.50 per unit.

TELEPHONY—TELEGRAPHY, and WIRELESS.

INSPECTION OF TELEPHONE WIRE.[1]

BY HUGH T. WREAKS.[2]

The operation of a telephone system involves, from the mechanical or engineering side, the use of a large variety and number of appliances, apparatus and material, all of these being grouped so as to form a large number of complex and interwoven circuits for the purpose of transmitting signals, both physical and vocal, by means of electric current.

I think it may be safely stated that each of these circuits is composed of more than ninety per cent of wire of one kind or another; and, therefore, that the efficiency of any telephone system and, to this extent, its success, depends very largely on the reliability of the wire used and how well this wire confines and protects the telephonic electric current passing over it.

There are several kinds and qualities of wire and cable used; those that I am familiar with being as follows:

1. Telephone cord.
2. Twisted-pair inside wire.
3. Twisted-pair bridle wire.
4. Pothead wire.

Nos. 1, 2, 3, and 4 are all soft-drawn copper.

5. Twisted-pair outside wire.
6. Bare copper wire.
7. Weatherproof wire.

Nos. 5, 6, and 7 are all hard-drawn copper.

8. Copper-steel wire.
9. Weatherproof copper-steel wire.
10. Galvanized-iron wire.
11. Lead-covered paper cables.
12. Aerial cables, rubber-covered copper wire.

All of these wires, when bought by the American Telephone & Telegraph Company, Western Union Telegraph Company, United States Government and, presumably, when bought by various members of your association, are covered by specifications which go quite into detail as to various characteristics, tests and requirements to which these wires shall conform. These tests and requirements are passed upon, as a rule, at factories where the wire is made up, and almost invariably cause the rejection of a certain number of coils of such wire, which latter are known as culls. These culls frequently go to such purchasers as do not have their wire inspected.

These tests are sometimes quite complicated and require an appreciable quantity of reliable and expensive apparatus and equipment. Though not infallible, if properly made they are a valuable guide to purchasers of wire. It might not be amiss to enumerate some of these tests and explain what they mean and how they can be interpreted. For convenience, I will group these tests as follows:

Tests on braid.

Tests on rubber insulation—ordinary grade.

Tests on rubber insulation—high grade.

Tests on copper wire—soft drawn.

Tests on copper wire—hard drawn.

Tests on tinning.

Tests on copper-steel wire.

Tests on galvanized-iron wire.

Tests on lead-covered paper cables.

Qualities of Braided Coverings.—The braided covering on a wire serves two functions, which are not always appreciated. It adds strength to the wire, and should serve as a protector for and prevent action of air on the compound or conductors underneath.

This means that when the braid is exposed to the atmosphere it should withstand temperatures varying from, say 130 degrees to zero, Fahrenheit, without any deleterious effect on the braid itself or the preservative and air-excluding compound with which it is saturated. The braid should be so saturated with a waxy or filling compound as to absorb but little moisture. Any braid which continuously absorbs appreciable moisture and then dries out will rot in a relatively short time. The braid should be strong and flexible enough to protect the conductor during ordinary process of handling, and if strong enough not to be injured in handling, it is likely to give a good account of itself in service. Unfortunately, the qualities here mentioned are not all consistent with one another. That is to say, those waxes which best exclude water may tend to stiffen the wire and crack the braid when bent, or if put into the braid at a temperature high enough to thoroughly saturate it, they may slightly char the braid fiber. Again, the waxes which best withstand high temperatures will not best withstand low temperatures, although of the two the former is, I believe, generally considered the most important. To cover these points properly requires specifications which strike a mean.

No great amount of apparatus is required to make tests on braid, the high temperature being developed by a water-jacket oven, and the low temperature by a freezing mixture. The moisture-absorbing qualities are tested by carefully weighing selected samples on a good chemical balance before and after a twenty-four-hour immersion in water, and the strength and flexibility of the braid are determined by a combination of bending and straining tests, together with comparison of the number of yarn ends and ply and size of cotton used in the braid.

The rubber insulation, both low and high grade, has been in the past and is even now, to a less extent, a bone of severe contention between purchasing agents and wire manufacturers. That is to say, it is found difficult to so specify that the manufacturer of a good compound will be protected against the competition of a poor compound. Yet much can be accomplished, even here, by proper specifications.

1—A paper read at the Technical Conference of the fourteenth annual convention of the National Independent Telephone Association at Chicago, February 8.

2—Secretary, Wire Inspection Bureau, New York, N. Y.

The Insulating Compound.—The characteristics of a good compound are high insulating qualities; long life, both physical and electrical; and sufficient strength to withstand, without damage, such handling as it will receive when being installed. The quality of strength is not so important here, especially when the insulation is covered by a braid, as the latter, if good, gives to the wire its requisite strength. There are, however, many engineers who claim that a relation exists between the electrical, physical and aging qualities of a rubber insulation, but we have made a great many experiments without discovering such relation.

As to tests, the apparatus for electrical tests on rubber insulation is quite expensive and cumbersome. First, it is necessary to install large water tanks, together with necessary cranes and other apparatus for handling the coils and putting them in and removing them from the water, as all these electrical tests on rubber compounds are made on coils immersed in water. Transformers of ample capacity and capable of giving at least 3,000 volts and preferably 10,000 volts are needed, together with switchboards and other apparatus for the purpose of applying the necessary voltages so as to locate the weak spots, which either show up immediately or are observed when the insulation resistance is taken. The insulation-resistance test requires a sensitive galvanometer, so mounted as to be free from vibration, together with the necessary scale, telescope, shunt, high resistance and batteries.

Three Tests for Compound.—The physical tests on ordinary-grade insulation may be classified under three heads: hardness, flexibility and softness. The test for hardness requires no apparatus except a sharp knife and a little practice, and consists in carefully removing the braid and then wrapping the insulation on itself and seeing that no crack develop in less than twenty-four hours. The test for flexibility consists in wrapping the insulated and braided wire, under tension, around a small mandrel immersed in water, and measuring by electrical tests the damage, if any, that has been done.

The tests for softness are made directly on the insulation and, by means of an electrical circuit and a scale, tell how many pounds pressure it takes for a given tool edge to cut through the insulation.

The physical tests on high-grade insulation are generally in the nature of a stretch and return test, say, from two inches to six inches and return in one minute to two and one-fourth inches, then to stretch without breaking to nine inches. They also call for a breaking strain of, say, 800 pounds per square inch.

Also, the specifications for high-grade rubber insulation generally call for chemical tests, these being in the nature of identification tests. These also serve a useful purpose, but, at times, from their delicate and intricate nature, are liable to be misleading. As yet, no chemical tests of value have been developed for ordinary-grade rubber compounds.

How Copper is Tested.—The tests for both soft and hard-drawn copper are, in the main, alike in kind but very different in degree. The elongation test and breaking-strength test are called for, for both, and a twisting test is called for for soft copper. The hard copper, again, must be carefully observed for splinters, as, although these are not serious from an electrical point of view, they are very dangerous to the linemen who handle the wire.

In making tests for strength and elongation, a tensile machine is required which, for hard-drawn wire, has to register quite high breaking strains.

The twisting test on soft-drawn wire, except on large sizes, needs only a simple apparatus. Conductivity tests are also specified for both soft and hard-drawn wire, although for the former they are of less importance, as practically all copper when soft has a conductivity above specifications. When hardened during annealing, baser metals may be used which would appreciably lower the conductivity.

The resistance of the copper is, of course, important and is included in conductivity measurements, the two together helping to check up the lengths of the coils and the amount of a given order.

Of course the quantity of copper cannot be determined without a knowledge of its cross sections and measurements with micrometer calipers. These measurements are also essential to properly check up insulation and braids.

Why Copper Wire is Tinned. — The tinning of wire is put on in order to preserve the copper, presumably against any action from free sulphur or oxidizing agents in the rubber compound, and also to protect the copper from the air in case the braid and compound on the wire are damaged in spots. This latter occurrence is, however, not anticipated and will require a tinning much heavier than is generally used. The tinning of copper wire is not as simple an operation as would at first appear, as the tin must be put on before the wire is insulated and must, therefore, form a flexible coating and not one likely to be damaged in the handlling before insulating and in this process itself. Obviously, too thick a coating of tin would be likely to chip off in this handling. The tests on tinning are, first, a chemical test which, by means of alternate immersions in solutions of hydrochloric acid and sodium sulphide of stated strength and for stated periods and times, tells in effect the amount of tin on the wire. Should this test, however, be made too severe, it might compel so thick a coating that the latter would crack when the wire is bent. Another test specified is to bend the wire around a given mandrel dependent on size of wire and then immerse it in a sodium solution for stated intervals. Both these tests must be made with care, as otherwise the exposed copper ends of tested samples will affect the test, and possibly the solution. These tests are empirical in their nature and are what might be called factor-of-safety tests, being made under severer conditions than are generally met in practice. Again, since we have been making inspections and tests on wire, we have heard much of corrosion of copper in insulated wires, due to oxidizing agents, etc., in the insulation; these acting direct on the copper on account of defective tinning. But our experience to date with field samples fails to show any action of this kind which is clearly due to such causes, or what might be called internal causes. At the same time, all tinned wire can to advantage be inspected before insulation, to show that tin was properly applied and the copper wire is free from splices and sufficiently smooth to permit of good tinning.

Every sample of wire which we have yet seen in which the copper was corroded also showed the rubber and braid badly decayed or dried out and, conversely, where the braid and its saturation appeared still good, the insulation, tinning and copper seemed O. K. This evidence is, however, negative rather than positive, but would indi-

cate that the tinning is generally well put on.

Tests on Copper-Clad Wire.—Copper-steel, or, as it is sometimes called, copper-clad wire, is a relatively new product commercially and, therefore, as yet not so much is known about how it develops with age, and the specifications under which it is bought are more nearly a manufacturers' than a commercial specification. Certain essential points, however, seem obviously to offer opportunities for tests: The per cent of copper, as determined by cross sections and resistance; the resistance itself; the breaking strain; and the nature of the weld of the two metals. The breaking strain, resistance and cross sections can be told by methods indicated for ordinary copper wire. The nature of the weld can be told after a sample section has been properly polished and etched and examined under the microscope. An apparently practical test, also, consists in bending the sample around a mandrel of stated size and coating it with a prepared solution of gelatin, water, sulphuric acid and potassium ferricyanide; the exposed iron showing up as a blue coloration of the gelatin. Both these tests are, however, somewhat new and I am not at this time fully prepared to pass on their value.

Much can, however, be told of the value of the copper coating by examining bent samples of copper steel under a good glass or microscope.

Galvanized-iron wire is, in a way, analagous to copper-steel wire except that it lacks the low resistance qualities of the former. Similar tests are, however, called for in the way of cross-section measurements, weights, resistance, tensile strength and the value of the galvanizing coating. All except the tests on galvanizing coating are like similar tests on copper and copper-steel wire and the coating tests are, in a way, analagous to those for tin coating on copper. The solution is different; to test for galvanizing a copper-sulphate solution is used, and in cast of poor galvanizing a deposit of copper shows on the exposed steel. Bending tests around mandrels of stated size are also of value as showing whether the galvanizing will crack, although these latter are considered by some engineers as not practical, as a galvanizing coat thin enough to stand appreciable bending will not give to the wire the protection against weather which should obtain. Also the claim is made that where this galvanized wire needs to be bent in splices, it is impossible to get any galvanizing of value ductile enough to stand the short bends that are required. Further than this, splices in question should always be specially protected so that any exposed iron, due to cracking of the galvanizing, will not rust.

Factory Tests on Telephone Cable.—Lead-covered cables, in a way, are the most important, I believe, of any class of conductors used in telephone service; this on account of the large number of circuits they contain, the fact that they are generally placed underground and hard to test and repair, and also because they are expensive and costly to install. The tests called for here are conductivity tests, capacity tests, high-voltage and insulation-resistance tests and tests on paper used for insulation and the thickness, quality and application of the lead cover. The resistance, capacity and high-voltage tests require the same factory apparatus called for in tests on rubber insulation and, in addition, special testing apparatus to measure electrical capacity. These tests are mostly made on cable not immersed in water, although sometimes this latter is required on voltage and insulation-resistance tests, although, unless some reason exists for doubting the manufacturer's ability to lead his cable, the water immersial seems to be an extreme requirement, and a test without water immersion, together with the manufacturer's guarantee on this point, would seem to be all that is essential. The tests on the lead covering itself are, first, as to thickness, which is a direct measurement; and then whether the lead is composed of the proper material; this being in the nature of a chemical analysis to determine the quantities of tin, zinc, etc., and whether these are in such proportions as to make a ductile and durable cover.

Cable Paper Must Resist Moisture Penetration.—The quality of paper used as insulation on the wires is important; it should be tough, of good quality and treated so as to resist absorption of moisture, although leaded paper cables are supposed to be entirely free from moisture, and the lead is to keep all moisture out, while the sole function of the paper is, I believe, to form the necessary mechanical separation of the individual wires from each other.

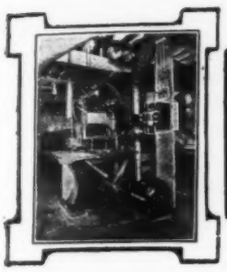
Why Inspection of Material Pays.—So much for technical and specific points. There is also a decided commercial value to specifications and tests and inspections at factories, in that such specified, inspected and tested wire is more carefully made up by the manufacturer, for his own protection, and, according to his skill, with a greater or less margin of safety than actually required. This is done on the theory that some of his material will always average below the balance. Again inspected materials are treated with more care in shipment, as damage in handling could be more easily traced. Again, these shipments are more prompt and complete, as there is a representative on the spot following them up; and where certain lengths are specified or methods of shipments, reels, coils or certain size of coils, tracers, twists, etc., these can be checked up more easily by factory inspection than in any other way.

The purchasing agent working with a proper specification will obtain samples promptly when shipments are made and can see for himself their general characteristics; these samples, properly tagged and set aside by him or, in any event, similar samples set aside by the inspection bureau, will keep an actual record of this particular lot of material and afford a valuable check against improper handling of it by linemen in the field.

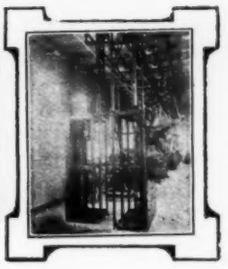
In conclusion, I have not meant to carry the idea that specifications and factory inspections and tests are a panacea against all wire troubles, but simply to claim they are of considerable value in reducing the same and, if properly made and followed up, will serve as one of the many checks which mark the difference between the well-managed company and those exercising less business care and ability.

Mackay Company's Extensions.

During the past year the Mackay Company completed an 830-mile trunk line between Oakland, Cal., and Salt Lake City, a distance of about 830 miles. This gives the company its third main telegraph line to the Pacific Coast. All of this construction was of the most modern type, only copper cables running twenty pounds between poles being used. In addition the company has put in sixty lines of the same copper type between several Pacific Coast cities.



Industrial Power



MOTOR DRIVE IN PLANT OF WILLYS-OVERLAND COMPANY.

BY W. A. HILL.[1]

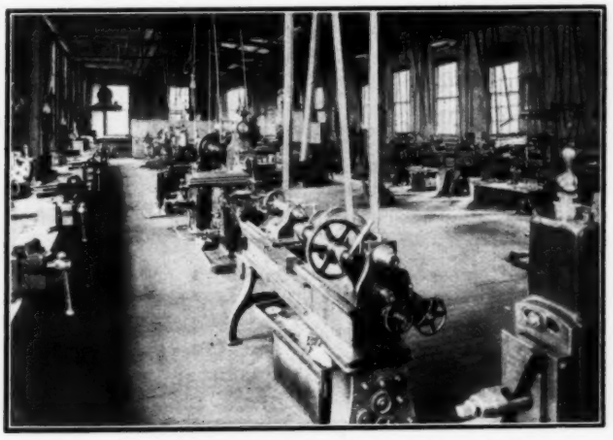
In the early part of the summer of 1909 the Willys-Overland Company took over the plant of the Pope Motor Car Company of Toledo, O., to manufacture automobiles. The generating equipment then consisted of two 100-kilowatt 550-volt, direct-current belted generators for power, and four twenty-five-kilowatt 110-volt direct-current bipolar generators for lighting. The machinery was group driven with motors ranging in size from one to fifty-horsepower, the total connected load being about 650 horsepower. In most cases the motors were mounted on the floor in a corner of the room, in some instances, however, one motor was used to drive machines on three floors.

Auxiliary power was purchased from the local traction company for both lighting and motors. Since the purchased power for motors was from the trolley circuit with its attendant fluctuations and since the number of buildings in the plan was to be tripled and consequently the amount of power required increased proportionately, it was deemed advisable to either install an alternating-current generating equipment or to purchase power of this character. Owing to the lateness of the taking over of the plants and the desirability of building automobiles that season, the installation of the necessary generating equipment was out of the question. This left but one avenue for securing the desired power. It was therefore, decided to use central-station power, as this could be procured in a short time, and the cost per kilowatt hour would probably be no more than that of an isolated plant.

Three-phase twenty-five-cycle current at a pressure of 4,000 volts is transmitted from the central station, situated about three miles distant, through one-half mile of underground and two and one-half miles of overhead feeders of solid copper wire, and a neutral of No. 4 copper wire grounded at the powerhouse. The high-tension feeders are brought over the property on poles to the transformer station located at the center of distribution. After entering the transformer room the current passes through a 300-ampere, 6,000-volt, three-phase, automatic overload oil switch and from that to the overhead wire busses of rubber-covered wire, extending along brackets placed above transformer banks.

Two banks of transformers, one of three 200-kilowatt and one of three 100-kilowatt single-phase 2,200/440-volt transformers, star-delta connected, are used for power circuits. Each bank has a primary oil switch located on the wall and a secondary quick-break knife switch on the switchboard. This permits the banks to be operated singly or in parallel. For lighting, two banks of fifty-kilowatt twenty-five cycle, 2,300/115-volt star-delta connected single-phase transformers are used which are provided with the same switching arrangements as above. An indoor type, three-phase, electrolytic lightning arrester is used for lightning protection.

VIEW OF SWITCHBOARD AND TRANSFORMERS.



MOTOR-DRIVEN MACHINES IN TOOL ROOM.

The switchboard is located in the same room and directly opposite the transformers. It consists of two main control panels and four feeder panels. Each control panel has one 1,000 ampere and one 2,000 ampere quick-break, knife switches, rear fused, an ammeter so arranged that current can be read in each wire and voltmeter to read voltages across any phase. Each of three of the feeder panels has four 200-ampere rear-fused switches, while one panel contains two polyphase integrating wattmeters. The lighting board is very similar to the power switch-

[1] Chief Electrician of Willys-Overland Company.

board. On a sub-panel located immediately in front of the power transformers is placed a 3,000-kilowatt curve-drawing wattmeter. This measures the total primary current entering the station. Current transformers for the integrating wattmeter are placed on the same panel.

The lighting transformers mentioned above have five-per-cent and ten-per-cent taps. It was found that when the motor load was on, the resistance drop increased to such an extent that it was perceptible in the lighting and in consequence it was found necessary to use the five-per-cent tap. When the motor load begins to increase, the electrician in charge manually sets a switching device to the five-per-cent primary tap and when the motor load comes off at noon and evening the weighted automatic contactor switches the primary on to the full tap. The automatic contactor is so set that its range is within the motor load-factor and this makes it unnecessary to set it more than twice daily. To facilitate checking of the automatic contactor a curve-drawing voltmeter is installed.

There are six elevators with a capacity of 4,000 pounds at sixty feet per minute. These are direct connected to twenty-horsepower 440-volt, three-phase, twenty-five-cycle motors, operating at 720 revolutions per minute, with wound rotors and external resistance. There are also three elevators with twenty-three-horsepower motors, with wound rotors and external resistance, each having a lifting capacity of 5,000 pounds at sixty feet per minute. These elevators have devices in the hatchway to throw out the circuit-breaker should the control fail at the top or bottom of the shaft.

Owing to the character of manufacture and plant arrangement, group drive was adopted with the exception of a very few cases. Circuits of 000 and 0000 rubber-covered stranded wire, run open on ceiling with conduit from ceiling to starter and from starter to motor, are used. A switch and a set of fuses are placed before the starter and another set of fuses between starter and motor. In the set of fuses the center one is of capacity equal to the sum of the two outside, since in starting the motor the starting voltage taps shunt the outside fuses.

The total connected load is about 1,600 horsepower in 440-volt, three-phase, twenty-three-cycle motors, ranging in size from one to seventy-five horsepower. Each circuit has about 150 horsepower connected.

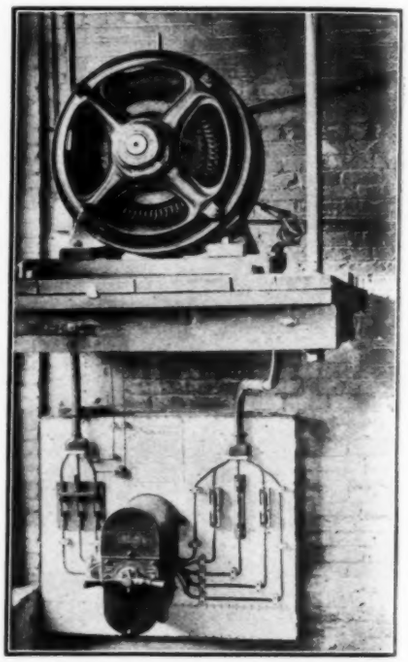
The direct-current motors which have been replaced, were set on the floor and belted to the line shaft at about forty-five degrees. Owing to the amount of space required for the motor and belt, which necessarily had to be boxed in so as to eliminate possibility of employees coming in contact with it, it was deemed advisable to either suspend the new motors from the ceiling or place them on a platform. The arrangement of the tools was such that most of the group drives demand twenty to fifty horsepower. Motors of this size are not so accessible when suspended from the ceiling, neither will the ordinary ceiling permit of such an arrangement without extra reinforcement, consequently everything favored the platform installation. The ceilings average about sixteen feet from the floor, and the platform clears the floor eight feet. In some instances platforms are placed in the corners of rooms while in others they are placed in the center or near side wall. Platforms are large enough to allow the removal of the rotor without lowering any parts to the floor below. These also put the motors beyond the reach of all except those taking care of them.

Where the platform is located in a corner the walls carry a portion of the weight of the frame through a projection of the frame timbers mortised into the brick work. The frame is further tied to the wall by means of lagged straps which pass through the brick work. Side platforms are very similar except that additional tie rods secure outer corners to the wall thus eliminating lateral vibration.

In most cases the potential starter, knife switch and fuse blocks are placed immediately beneath the platform on asbestos-covered planking framed and bolted to wall. A snap switch controls a four-light cluster underneath the platform. The function of this cluster is not only to give light at this particular location but also indicates visibly when power is off or on.

In starting an induction motor one of the running fuses may blow and the motor will run single phase. If left in this condition very long, one of the windings may be burned out. To detect burnt-out fuses, an arrangement of a block with two-ampere fuse wire, with about six feet of lamp-cord leads and terminals similar to those on a portable voltmeter is used. By shunting this on the fuses to be tried any fuse that has blown will indicate by blowing the two-ampere fuse wire. This is a cheap and quick device and can be used while the motor is running.

Some difficulty was experienced due to the static electricity generated by the slipping of the belt on the iron line-shaft pulley. Various brush devices were tried to take static from the belts, but these soon became deranged and rendered useless from various causes. All motor frames are now grounded through about 200,000 ohms resistance made up of two .25 by 12-inch round graphite resistance rods which effectively remove the static from the motor.



TYPICAL MOTOR INSTALLATION, SHOWING WALL PLATFORM.

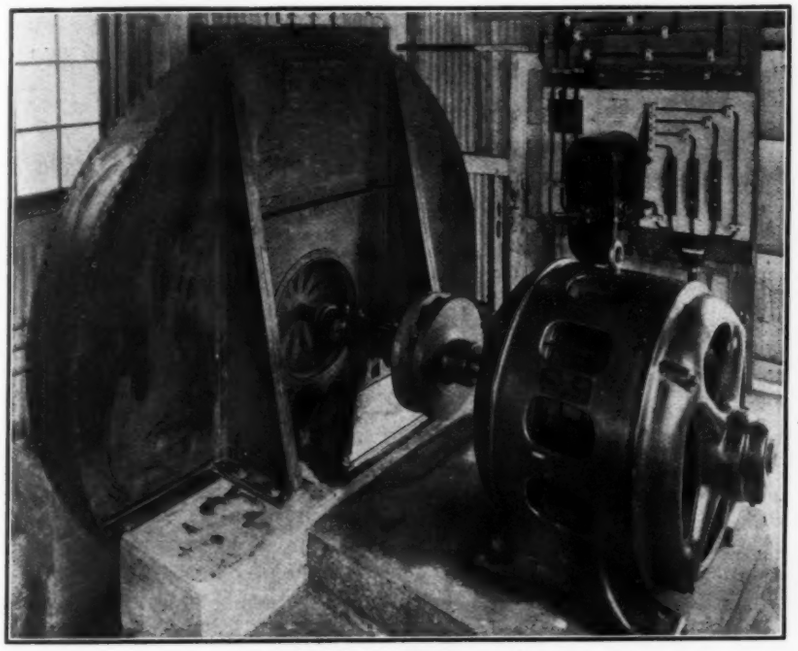
Compressed air is piped in most departments to operate portable tools or to keep machine tables free from chips. Taps are taken from this general distribution system and a three-eighths-inch pipe is carried in close proximity to motor, terminating in a valve and male portion of a union, to receive the hose for blowing out the motors, which operation is performed once each week.

Oil is changed in the bearings and

the bearing washed with gasoline every six months. Those that are in dirty places are cleaned more frequently. A portable ammeter is taken around to the motors at frequent intervals or if a motor appears to be overloaded, and ampere readings taken. As near as is possible the motors are loaded to full load. By changing motors to suit the load, the power-factor and load-factor are maintained reasonably high. At present the load-factor is seventy-five per cent and power-factor eighty-two per cent.

Power for lighting is distributed through three-phase feeders from the main switchboard to the various factory buildings and from there single phase to the distributing panels. By this method a good balance is maintained and there is quite a saving in copper over two-wire distribution. Illumination is one of the most difficult electrical problems in an industrial plant, and many arrangements have been tried in the Willys-Overland Works. The scheme of general illumination has not proved satisfactory in this plant. Flaming arc lamps are used in the forge room suspended about twenty feet from the floor, but owing to the low frequency of the current these are not any too satisfactory as the flicker is very noticeable. About 500 200-watt Gem lamps with frosted tips for general illumination spaced from 20 to 25 feet apart, with white enameled tin shade are used. These have proved very satisfactory and have the advantage that they may be washed without danger of breakage. The series Mazda cluster with four 100-watt 28.6-volt Mazda lamps, with white enameled steel shades suspended by a spring to take up vibration, is now being tested. Common sixteen-candle-power carbon lamps are used at all machines and benches. These have an eight-inch cone tin shade.

There are three electric welding machines which are used to weld various parts that enter into the manufacture of an automobile. Two of these are for butt-welding and one for spot-welding. Each machine is connected across one phase of the three-phase 440-volt power circuit. To butt-weld three-fourths-inch round steel stock it takes from 25 to 35 seconds and an average of about forty-eight amperes current consumption.



INDUCTION MOTOR DRIVING BLOWER.

The motors installed have given exceptionally good service and have been found to be liberally rated as upon many occasions they have been heavily overloaded for long periods and heating was not noticeable. Form-wound coils in open slots are used in the motors and this feature has shown a great saving of time, inasmuch as they can be replaced in about one-third the time and with less damage to the coil when removed. The motors are of the four-pole type with the exception of those on three elevators, and are of Allis-Chalmers manufacture.

All parts of the starting apparatus are reasonably accessible and adjustments of wearing parts can be made as desired. Cards bearing warnings as to live parts of circuits and manner in which the starter may be put into commission are placed at the side of the starters on the walls.

Central Station Working With Contractors.

To show that there are localities in which there is co-operation between the central station and the electrical contractor, the National Electrical Contractor publishes the following scheme which was presented in booklet form to the St. Joseph (Mo.) citizens by the St. Joseph Railway Light, Heat & Power Company:

"Fully realizing that many hundreds of citizens of St. Joseph would like to have electricity in their homes and fully appreciating that many are prevented from gratifying their desire owing to what they consider an excessive first cost for wiring and fixtures, the St. Joseph Railway, Light, Heat & Power Company has made special arrangements with the several electrical construction houses in the city by means of which anyone on its lines or near enough to permit of a profitable extension may have his house wired and fully equipped with fixtures at about one-half the normal cost.

"Briefly our wiring proposition is as follows:

"A customer must sign a contract with us for having his place of residence wired, also a one-year lighting contract. In all cases we reserve the right to pass upon the credit of anyone wishing to avail himself of our house-wiring proposition. The St. Joseph Railway, Light, Heat & Power Company will allow the purchaser five months' time in which to pay for his wiring and fixtures. The company pays the construction house cash when the work is completed.

"It should be understood we have adopted a standard specification for different sized houses. The work will be of the highest class and strictly in keeping with the National Code specifications. If any extras, such as wall switches, side brackets or additional fixtures are desired other than those included in our specifications, they must be purchased from the contracting coonstruction house doing the work, and payment must be made by the customer direct to the contractor."

The customer may select any responsible contractor satisfactory to the lighting company.

Before the opening of the International Exposition in Turin this year, the railroad up Mont Cenis will be equipped for the use of electric power. Fifteen-cycle, three-phase current will be used at 7,000 volts. Transformers are used to step down from 48,500 volts at fifty cycles and rotary frequency changers are connected to the secondary side. The electric locomotives are rated at 2,000 horsepower.

FINANCIAL REPORTS OF ELECTRICAL COMPANIES.

AURORA, ELGIN & CHICAGO.

The report of Aurora, Elgin & Chicago Railroad Company for the month of December and six months ended December 31, compares as follows:

	1910.	1909.
December gross	$124,874	$117,202
Expenses	85,363	72,794
December net	39,511	44,407
Charges and taxes	34,850	30,912
December surplus	4,661	13,495
Six months gross	934,457	858,006
Expenses	503,834	444,902
Six months net	430,623	413,104
Charges and taxes	201,893	177,574
Six months surplus	228,730	235,530

METROPOLITAN WEST SIDE ELEVATED.

The Metropolitan West Side Elevated Railway Company, Chicago, has issued its report for the year ended December 31, 1910. The income account compares as follows:

	1910.	1909.
Gross earnings	$3,069,945	$2,818,431
Operating expenses	1,556,015	1,418,076
Net earnings	1,513,930	1,400,354
Other income	8,770	11,160
Total income	1,522,709	1,411,514
Interest, rental, taxes, etc.	1,079,969	1,062,596
Surplus for year	442,731	348,918
Dividends	261,237	.....
Surplus	181,494	348,918
Previous surplus	1,580,624	1,281,706
Total surplus	1,762,118	1,630,624
Depreciation and losses res.	50,000	50,000
P. and L. surplus	$1,712,118	$1,580,624

Details of operating expenses compare as follows:

	1910.	1909.
Maintenance of way and structures	$141,831	$134,350
Maintenance car equipment	173,927	165,172
Maintenance and operation power plant	376,483	312,706
Conducting transportation	663,313	605,095
General expenses	96,323	103,348
Loop operation and interest	107,138	97,405
Total	1,556,015	1,418,076

SHAWINIGAN WATER & POWER.

The Shawinigan Water & Power Company has issued its pamphlet report for the year ended December 31, 1910. The income account compares as follows:

	1910.	1909.
Gross	$991,029	$819,171
Expenses	127,386	118,048
Net	863,643	701,123
Interest	456,387	379,816
Balance	407,255	321,307
Dividends	286,378	260,000
Surplus	120,877	61,307
Reserve fund	85,000	60,000
Surplus	35,877	1,307

WEST PENN TRACTION.

The West Penn Traction Company, which recently took over the West Penn Railways Company, reports for the year ended December 31, 1910, as follows:

Gross receipts	$2,042,000
Div. on West. Penn. Ry. com. stock	65,000
Total receipts	2,107,002
Expenses and taxes	987,642
Net earnings	1,119,360
Charges	673,004
Surplus	446,356

Six per cent on the traction company's preferred stock would require $97,500, leaving a balance for the common of $348,856.

The net earnings are approximately an increase of $34.4 per cent over last year.

NARRAGANSETT ELECTRIC LIGHTING.

The Narragansett Electric Lighting Company has issued its pamphlet report for the year ended December 31, 1910. The income account compares as follows:

	1910.	1909.	1908.
Gross earnings	$1,215,745	$1,195,370	$1,088,364
Expenses	688,859	669,123	646,008
Net earnings	526,886	526,247	442,356
Charges and depreciation	198,604	181,623	107,453
Surplus	*328,281	344,624	334,903
Dividends	320,000	320,000	320,000
Surplus	8,281	24,624	14,903

*Equal to 8.2 per cent on $4,000,000 capital stock as compared with 8.6 per cent on same stock previous year.

CUMBERLAND TELEPHONE & TELEGRAPH.

The Cumberland Telephone & Telegraph Company has issued its report for the year ended December 31, 1910. The income account compares as follows:

	1910.	1909.
Gross	$6,897,081	$6,615,368
Operating expenses	3,894,410	3,879,440
Net	3,002,671	2,735,928
Charges and taxes	595,402	579,081
Surplus	*2,407,268	2,156,847
Dividends	1,574,412	1,574,412
Surplus	832,856	582,435
Previous surplus	3,969,168	3,286,202
Credit adj.	.....	100,530
Total surplus	4,802,024	3,969,168
Equal to 12.23 per cent earned on capital stock, compared with 10.96 per cent earned on same stock last year.	$19,680,150	

AMERICAN TELEPHONE & TELEGRAPH.

The American Telephone & Telegraph Company reports to the New York Stock Exchange for the ten months ended October 31, 1910, as follows:

Dividends received	$14,115,338
Telephone traffic	8,411,646
Real estate	79,207
Interest and other revenue from associated companies	9,413,190
Sundry	14,938
Total receipts	32,034,382
Expenses, taxes, interest, etc.	11,481,908
Surplus	20,552,474

CAPITAL TRACTION COMPANY.

The annual report of the Capital Traction Company, of Washington, D. C., for the year ended December 31, 1910, shows a surplus available for dividends of $820,598, equal to 6.84 per cent on the $12,000,000 capital stock, compared with 7.02 per cent on the same stock last year. The income account compares as follows:

	1910.	1909.
Gross revenue	$2,226,150	$2,024,484
Operating expenses	1,101,989	918,373
Net revenue	$1,124,161	$1,106,111
Other income	14,518	29,294
Total income	$1,138,679	$1,135,405
Interest, taxes and renewals	318,081	293,026
Surplus	$ 820,598	$ 842,379
Dividends	720,000	720,000
Surplus	$ 100,598	$ 122,379

CHICAGO TELEPHONE COMPANY.

The Chicago Telephone Company has issued its report for the year ended December 31, 1910. The income account compares as follows:

	1910.	1909.
Gross revenue	$11,331,153	$9,907,450
Expenses, repair and maintenance	†9,076,080	7,676,742
Net revenue	*2,255,072	2,220,708
Dividends	2,160,000	2,160,000
Surplus	95,072	60,708

*Equals 8.35 per cent earned on $27,000,000 capital stock, compared with 8.22 per cent earned on same stock last year.

†Includes $3,888,532 for repairs and maintenance.

The falling off in average revenue per telephone in Chicago in toll service is attributed to the heavy increase in the number of low-priced telephones. An increase of 38,259 'phones, of which 31,364 were in the city and 6,895 outside of the city, was the largest gain made in a single year in the history of the company. The company's employes now number 9,370 compared with 8,104 a year ago.

EDISON COMPANY OF BOSTON.

The report of the Edison Electric Illumination Company of Boston, for the month of January and seven months ended January 31, 1911, compares as follows:

	1911	1910
January gross	$ 548,474	$ 468,119
Expenses	210,364	203,165
January net	338,110	282,954
Seven months' gross	3,034,713	2,723,777
Expenses	1,292,888	1,234,623
Seven months' net	1,741,825	1,489,154

STONE & WEBSTER COMPANIES.

The combined statements of earnings of electric railway, electric lighting, gas and water power companies (thirty-one companies in all) under the management of Stone & Webster, for the year ending December 31, 1910, follow:

Gross earnings	$22,023,126
Operating expenses	12,251,915
Net earnings	9,771,211
Taxes	1,144,498
Operating income	8,626,713
Interest charges	3,674,139
Balance	4,952,574
Dividends paid	2,885,763
Surplus	2,066,811

Miles of equivalent single track operated, 1,092; passengers carried, 286,943,000; total connected electric lighting load equivalent to 16-candlepower lamps, 2,094,920; total commercial power load approximately, 112,100 horsepower; total combined power-station capacity approximately, 185,800 horsepower, of which 84,400 horsepower is generated by water power.

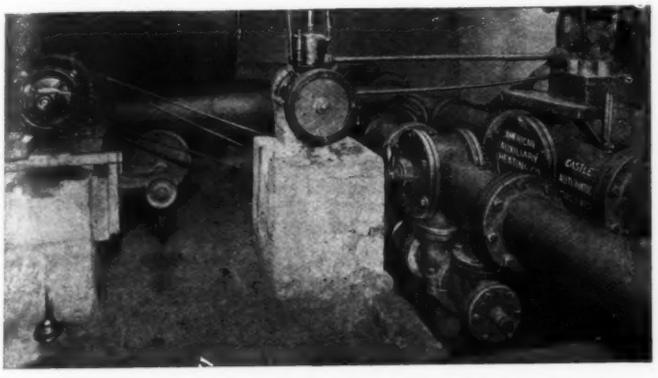
Earnings of the Western Electric Company for January, 1911, were slightly in excess of those for the same month last year. The increase applies to both domestic and export trade.

New Electrical and Mechanical Apparatus and Appliances.

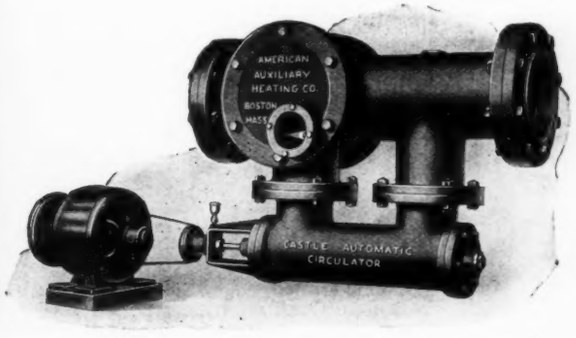
A Water Circulator with Electric Drive.

A recent addition to the rapidly growing list of house auxiliaries which are designed to be operated from the electric lighting circuits, is the Castle automatic circulator for use in hot-water heating systems. Although this device has been on the market for some time it has not been pushed to any great extent until recently, when it was taken over by the American Auxiliary Heating Company, Boston, Mass., which is now putting it on the market.

Although the circulator may be operated by a small gas engine or some other means, by far the best method of driving this apparatus is by means of an electric motor, and it is therefore particularly applicable in buildings which are equipped for electric lighting.



INSTALLATION OF WATER CIRCULATOR.



MOTOR-DRIVEN WATER CIRCULATOR.

The circulator is manufactured in three sizes, which are operated by one-eighth, one-fourth and one-half-horsepower motors, respectively. The accompanying cuts show an electrically driven water circulator, belt connected. It is more usually operated by means of a belt as the slippage possible in starting up is of advantage in prolonging the usefulness of the motor, although where care is exercised it is easily possible to start a direct-connected set without doing damage to the motor.

Both direct and alternating-current machines are supplied for this service according to the character of the current available. The circulator proper consists of a small propeller situated in a by-pass line in parallel with the hot-water return main. An automatic balanced valve is set at the junction of the discharge side of the by-pass and the return main. When the circulator is in use the force of the current of water passing through the by-pass causes this valve to rise and take up a position shutting off the main return line. When the propeller is stopped natural circulation is resumed and the water passing along the main return pipe forces down the automatic valve and thus shuts off the by-pass. This device is peculiarly automatic in its action, the only operation required to start and stop the machine being that of starting and stopping the motor.

The advantages obtained by the use of the circulator are numerous. By its use a hot-water system can be made as flexible and quick heating as steam. No longer is the heating system dependent for a head necessary to circulate the water upon a difference of temperature between the supply and return lines. With the positive mechanical circulation possible with the Castle circulator the returns are within a few degrees of the supply lines, accordingly, it is not necessary to heat the former through a great range of temperature in order to bring the temperature up to the proper point for distribution to the radiating surfaces. Instead of shoveling on coal to meet a sudden drop in temperature, it is only necessary to touch the button and start the motor going to insure a rapid distribution of heat throughout the system. Thus, the heater may be operated at all times with a steady moderate fire which will insure complete burning of the coal and a consequent diminution of waste. A saving of from 25 to 30 per cent in the yearly coal bill is not at all unusual, and opposed to this, the amount of power required for operating the small motor of the circulator, which runs only a part of each day, is very small.

In greenhouses where a steady mild heat is absolutely essential the circulator, it is said, has met with universal success and has been particularly efficient in solving heating problems due to poor layouts. It is particularly true of hot-water systems that proper pipe sizes, pitch and position and number of turns must be carefully attended to if proper circulation is to be attained. In numerous cases, where sufficient care has not been exercised, an unsatisfactory system has been changed into a successful and economical installation by means of the circulator.

This device offers one more field of usefulness for the small electric motor and is another striking example of mechanical devices depending almost entirely for their successful operation on the assistance of electricity.

Eliminating Smoke.

The problem of burning coal in large quantities in power plants located within the city limits without producing smoke is becoming a very serious matter in view of the strenuous endeavors being made by municipalities everywhere to insure cleanliness and more healthful conditions by the suppression of smoke. So insistent has be-

come the demand that great quantities of black soot should not be allowed to sully the beauty of public buildings that many cities have passed stringent smoke laws and provided a staff of inspectors to insure their enforcement.

The power-house man, whose duty it is to furnish steam as efficiently as possible and with the cheapest coal with which the desired results can be obtained, has found it necessary in very many cases to make heroic efforts to meet the demands for smokelessness without the expenditure of a prohibitive amount in equipment.

In this connection, the success of the Cleveland Street Railway Company, of Cleveland, O., in mitigating the smoke nuisance in its Cedar Avenue Station is particularly noteworthy. This power house, being located in the residential section of Cleveland, was in position to make itself unusually obnoxious by the production of smoke, and not only was the Company faced with the problem of eliminating the smoke production, but it was also necessary to increase the capacity of the plant.

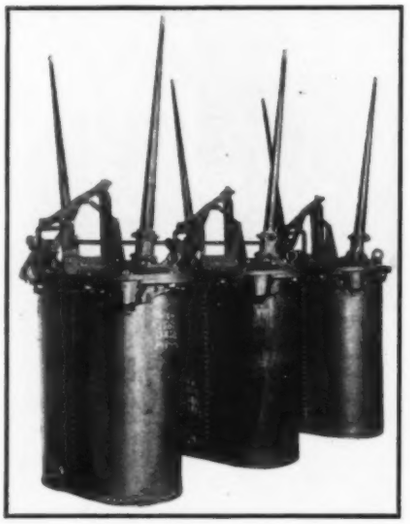
The boiler equipment consists of Stirling and B & W water-tube boilers and the fuel used was a low-grade Ohio coal which smoked excessively. After considering the matter it seemed that one of three possible methods should be adopted. First, by burning a high-grade coal to obtain greater capacity with less smoke; second, by installing additional boilers; third, by installing gravity underfeed stokers under the original boiler equipment. From preliminary figures it appeared that the most economical method would be the third and in order to obtain proof of this, a trial installation of one Taylor Gravity Underfeed stoker was put in another power station belonging to the Company.

After this stoker had been in use several weeks it was found that its operation was smokeless at practically all loads and all grades of fuel. It was then thoroughly tested as to capacity and efficiency and the results were so satisfactory that three Taylor stokers were ordered for the Cedar Avenue power house and have been recently installed there.

The success of this type of equipment in eliminating the smoke nuisance is due to the fact that, instead of attempting to do away with the smoke after it has been formed, the design is such that proper chemical reactions are assured to prevent the formation of smoke. By feeding the coal underneath the fire bed and gradually distilling the green fuel, the volatile hydrocarbons combine with a sufficient amount of air and are burned smokelessly in the hottest zone of the fire; the production of smoke is thus eliminated. Overload capacity at high efficiency is made possible by the correlation of air and coal supply in proper proportions. Accordingly, the limits to which this type of stoker may be driven are the limits of power of the fan engine which produces the forced draft and at the same time operates the stoker mechanism.

High-Tension Condenser-Type Terminals.

A new type of terminal for high-tension apparatus has recently been developed by the Westinghouse Electric & Manufacturing Company, utilizing a principle not used for this purpose before.



CIRCUIT-BREAKERS EQUIPPED WITH CONDENSER-TYPE TERMINALS.

The terminal is constructed of alternate concentric insulating and conducting layers, forming a series of condensers which serve to make the distribution of potential stresses in the insulating material uniform and thus increase dielectric strength of the terminal. As a result a much smaller terminal can be used for a given voltage with a corresponding saving in cost of the entire piece of apparatus and a gain in dependability under conditions of abnormal stresses due to surges, lightning and similar causes.

It can be readily seen that any terminal passing through a metal tank forms in effect a curved condenser, the plates of which are the surface of the terminal and the surface of the hole or bushing in the tank. The insulation between the two is the dielectric of a condenser and is subject to all the conditions affecting such a dielectric. It can be shown both mathematically and experimentally that the static stresses in the dielectric of a curved condenser are not uniform throughout the thickness, but are greatest near the inner surface. Therefore the thickness of the insulation must be made such that the inner layers will not be subjected to dangerous stresses, which result in the outer layers being thicker than necessary. Looking at the matter in another way, if the insulation is designed for a certain voltage per inch of thickness, there will be danger of breakdown due to the higher stresses near the inner surface. For low voltages the unnecessary thickness of insulation is not important, but for voltages of 70,000 and over the ordinary insulator becomes so large as to necessitate an increase in size of the entire apparatus.

By interposing the metal layers, the difference in diameters of the plates of each condenser is reduced and the distribution of the potential made more uniform, which results in a saving of unnecessary thickness of insulation. An idea of the saving effected can be had by a comparison of two terminals designed and tested for 200,000 volts. An ordinary bulk-type terminal for this voltage is about nine feet in length and sixteen inches in diameter, including insulation. A condenser-type terminal for the same voltage is seven feet in length and four inches in diameter, the volume of the former being eight times the latter.

The condenser-type terminal is constructed by winding the successive layers on a central outlet tube. The insulating layers consist of a special grade of paper wound under pressure and cemented and pressed together into a solid mass without weak spots. On each thickness of insulation is wound a layer of metal foil. The layers are so finished that each is shorter than the one beneath it, thus tapering the terminal and providing a creeping surface between successive conducting layers. The creeping surfaces on the end projecting into the air are, naturally,

larger than those at the end submerged in oil. A heavy metallic flange is fastened to the outside of the terminal to serve as a support for mounting it in the tank.

The accompanying illustration shows a 60,000-volt oil circuit-breaker equipped with condenser type terminals. The Westinghouse Electric & Manufacturing Company supply these terminals with all high-voltage transformers, circuit-breakers, electrostatic voltmeters and similar apparatus.

New Types of Motor Starters.

The two types of motor starters shown in the accompanying illustrations are being placed on the market by the Union Electric Manufacturing Company, Milwaukee, Wis., to meet the demand for such apparatus which has been created by the increasing use of electric motors in industrial establishments.

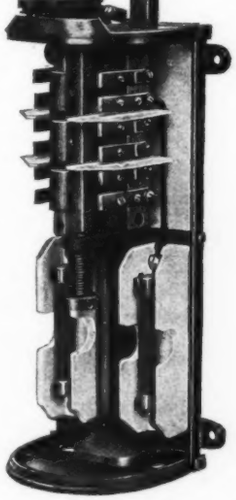


FIG. 1.—DRUM-TYPE STARTER.

In Fig. 1 is shown a drum-type starter for two and three-phase squirrel-cage alternating-current induction motors. It is designed to prevent the blowing of fuses or the operation of circuit-breakers, included in the motor circuit to protect the motor during the period of starting the motor. The object is accomplished by providing the starter with a starting position, a running position and an intermediate or off position, and arranging the switch handle from the off position to the starting position before the handle can be moved to the running position, and also to prevent the handle being left on the starting position.

In the starting position the fuses or other protective devices are short-circuited and are not included in the circuit until after the motor has started and the handle has been moved to the running position, thus protecting the fuses or devices from the excessive overloads due to starting.

The motor-protecting fuses are enclosed in the starter case with the contacts and are easily accessible by removing the cover. This construction provides a starter well adapted for use in woodworking and other plants, as all circuits are made and broken within the tight casing, thus eliminating danger of fire. In iron-conduit wiring the tubes can be extended directly into the case.

The parts are strong and durable and the construction is such that wearing parts are easily renewable.

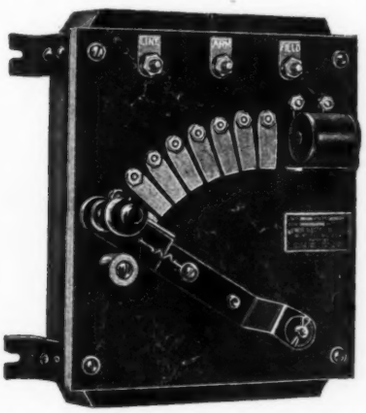


FIG. 2.—MOTOR STARTER WITH UNDERLOAD RELEASE.

In Fig. 2 is shown a Union motor starter with underload release. The resistance case is formed of sheet metal and is of the ventilated flame-proof type and meets all of the requirements of the trade and the insurance companies.

The construction is such that while the interior of the case is perfectly ventilated it is impossible for flame or molten metal to pass out of the case in the event of the destruction of the resistence through excessive overload.

The resistance tubes are insulated from the case by porcelain pieces which are so formed as to ventilate the interior portions of the case and also the interior of the resistance tubes.

As the resistance case and all parts on front of the marbleized slate are formed of sheet steel and brass, the liability of breakage during shipment or while in use is reduced to a minimum.

The starters are designed to prevent the lever from being left on any intermediate segment. The lever is adapted to be moved from the "off" position to the full "on" position and when in the full "on" position is held by the magnet as long as the magnet is energized.

The Family Motor.

The wide-awake central-station solicitor would have little difficulty in inducing every housekeeper in his territory, living in a wired house, to use electric-motor drive for every kind of work that it will satisfactorily perform, if it did not require a considerable outlay for motors and motor-driven devices. Indeed, he would be able to bring in contracts for wiring by the score.

The total cost of power for sewing, washing and wringing, mangle ironing, chopping meat, grinding coffee and polishing silver, would be a sum that almost any housekeeper would be willing to pay for a few hours more to call her own, or for being able to take a more independent stand on the servant question.

Electricity has advanced far enough now to give her the opportunity she has longed for, but for the woman living in a moderate-sized house and on a moderate income, the question of initial cost of all the appliances she would like to have and hopes sometime to possess, makes her hesitate.

The problem of operating many devices by a single motor has received much thought, and many solutions have been offered. The problem is somewhat complex, since the different machines require different amounts of power and must operate at different speeds; for example, washing machines and ice cream freezers must operate usually at speeds below 100 revolutions per minute, sewing machines at 600 revolutions per minute; polishing wheels at from 1,700 revolutions per minute upward.

J. Steiner of the Steiner Manufacturing Company, St. Louis, Mo., has devised a method whereby one motor may be used to drive successively the washing machine, the wringer, the ironing machine, the ice-cream freezer,

the sewing machine, the coffee grinder, the meat chopper and the buffing and grinding wheel. This method is working out very satisfactorily, and the one motor is doing the work formerly requiring several, thus reducing the first cost of the equipment without causing any increase in the cost of running. The Steiner outfit consists of an adjustable stand on which the motor is mounted and belted to a short three-speed counter shaft, from which the machine to be driven may be connected by belt or through a worm gear for further speed reduction. The equipment provides means for driving all of the machines previously mentioned and many of the machines themselves may be purchased with the motor.

The Fort Wayne Rock Drill.

The Fort Wayne Type "A" electric rock drill is the result of several years of development and testing under the most severe and unfavorable conditions of actual working operations. Contrasted with other designs making use of flexible shafts, solenoids, springs and other complicated devices, the Fort Wayne drill is unusually simple; consequently it is made exceedingly rugged and effective.

The drill is of the rotary hammer type, operated by an electric motor which is mounted on the frame of the drill proper. The mechanism of the drill consists of two parts, a revolving helve containing the hammers, and the chuck mechanism for holding and rotating the drill steel. An idler is conveniently arranged in connection with the flexible belt between motor and drill, which provides a means of regulating the speed of the drill. Thus all the advantages of hand drilling are obtained without the disadvantages usually incident to machine drilling.

The drill steel is held in the chuck by means of several spring-steel plates. When not striking rock, the blow from the hammer is absorbed by these buffer plates, which also retain the steel in the chuck while backing out of deep holes or in broken and uneven ground.

The drill casing, striking mechanism, chuck and buffer plates are all simple and very substantial. The floating hammers in the helve are of special steel and are completely cushioned by air chambers so that the jar of the impacts is reduced to a minimum.

The drill steel cannot be jammed into a fissure or a cleavage crack as a result of several conditions. Should a fissure be encountered the buffer head prevents the drill steel from being plunged forward. The drill steel is not reciprocating and before it can be fed far enough into a fissure to wedge, it has hammered for itself a square shoulder or face, due to the rapidity of the blows in connection with the constant and positive rotation of the drill steel. The resultant effect approaches that of boring.

Another point of excellence in the Fort Wayne drill is the simple method employed for the removal of cuttings from the hole being drilled. A specially designed steel, developed by the engineers, removes the cuttings by a boring action and does away with the use of hollow drills or water under pressure. Thus the big item of pressure systems, including tanks, hose, water lines, etc., is eliminated, to say nothing of the cost of maintenance and inconvenience incident to such systems.

While these drills are ordinarily used in a horizontal position, they can be used in any position and will drill holes at any angle.

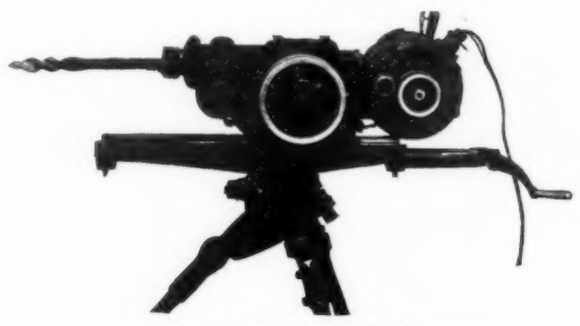
The ease with which power can be transmitted throughout the workings by wire and the rapidity with which the lines can be changed enables the operator to advance his work more rapidly than could be done when using other types of drills.

A comparison of tests of the Type "A" drill and air drills shows that the former requires from 1.5 to 2.0 horsepower, including transmission loss, while an average air drill requires from 12 to 18 horsepower for the same work. This is due to the design of the drill, the much greater efficiency of the electric motor and the small loss in transmitting power to the drill.

The simplicity and ruggedness of design of the Type "A" drill is a guarantee of low maintenance cost.

The drill can be operated with either alternating or direct-current motors and since the motor is entirely independent of the drill the change from one to the other is easily made.

VIEW OF ROCK DRILL SHOWING MECHANISM.



FORT WAYNE ROCK DRILL.

Solderall.

Recently there has been introduced on the market a new form of solder which is attracting great attention in electrical and kindred lines. This solder consists of a very finely pulverized tin solder combined with a special non-corrosive flux made into paste form, and put up in convenient collapsible tubes. It is known as "Solderall" and is convenient in handling, being complete, ready for instant use. All that is necessary when using it is to squeeze a little from the tube on the parts to be joined and the application of heat will make a perfect job. For joining wires and small work, an ordinary match can be used with success; for larger work, a hot iron or torch is recommended. "Solderall" may be carried around in the pocket. It does away with waste, and as it can be directly applied to the part where the solder is needed it gives a good finish.

Current Electrical News

GREAT BRITAIN.

(Special Correspondence.)

LONDON, FEBRUARY 11.—An interesting development of the application of electricity to the textile trade is announced. Messrs. Frears, Lord, & Brother are building a new weaving shed at Darcy Lever, Lancashire, which is to be electrically equipped throughout on the individual-drive system, each loom having its independent motor. Full tests lasting over many weeks were carried out with the loom motors of two firms, and the order for 510 one-half-horsepower and 175 three-quarter-horsepower, loom motors was placed with Siemens Brothers Dynamo Works, Ltd. fifty-cycle, three-phase current at 200 volts will be supply by the Lancashire Electric Power Company, which will provide a substation for the purpose of transforming the high-tension supply down to the required pressure. This is, I believe, the first individual loom drive of any size in this country, though the system is extensively adopted on the Continent, where a single firm has supplied over 13.000 motors for the purpose.

The system of telephoning with moving trains devised by H. V. Kramer, and known as the Railophone is to be installed on the Stratford-on-Ovon & Midland Junction Railway before the Shakespeare Festival in April.

The large power scheme which is being developed for the supply of electric power in Bombay, India, has made some development during the past few weeks, a contract having been let to a London firm of contractors for the hydraulic portion of the works. A London firm of consulting engineers has the electrical portion of the undertaking in hand. The area of the lake from which the supply will be taken is 1,697 acres and the water storage 2,560,000,000 cubic feet. From the reservoirs the water will flow in an open duct a distance of four miles, the power station being at Khopoli. There will be four 11,000-horsepower turbines of the Pelton-wheel type, the transmission voltage being 80,000. Steel towers are to be adopted for carrying the cables. June, 1913, is given as the date when the scheme will be in operation. The prospective requirements of the Bombay mills are put at 100,000 horsepower.

A conference is to be held in London on February 27, to discuss the question of present telephone rates. As the Postmaster General has declared that he will say nothing upon the subject until after the valuation of the National Telephone Company's plant is completed, it would seem that the conference will not gain much at present.

At the annual dinner of the Institution of Electrical Engineers this week. S. Z. de Ferranti, the president, made some strong comments upon the manner in which the intrusion of municipalities into the electrical industry in this country has retarded progress, and pleaded for a competition of excellence and not one of price. It was this, he said, that had developed the electric supply industry in our colonies and abroad, capitalists and manufacturers receiving better treatment outside England.

According to cables from Denmark, a new English company is to be formed to work the Poulsen wireless telephone and telegraph patents in this country.

WESTERN CANADA.

(Special Correspondence.)

WINNIPEG, CAN., FEBRUARY 18.—At Southey, Saskatchewan, a rural telephone company is now being organized and construction of pole lines will start as soon as weather permits. Rev. J. W. Graves is interested.

Announcement was made a few days ago that the British Columbia Telephone Company now has over 20,000 telephones in operation in British Columbia. Plans for the year include the installation of at least another 2,000 telephones.

The City Council of Winipeg has sanctioned the plans of the Winnipeg Electric Company for the construction of a number of branch lines in the city. Plans call for a new loop line connecting the northern and southern portions of the city. So far the company has not come to any agreement with the municipality of St. Vital for a suburban line from Winnipeg. The matter is still being discussed and an agreement is expected shortly. Wilford Phillips is general superintendent of the company.

The E. B. Reese Engineering Company of Chicago has made a contract to supply the City of St Boniface, Manitoba, with light and power. Several companies negotiated with the city and it was after lengthy controversies between friends of the various interests that the agreement was signed. The company will generate its power on the Winnipeg River which will necessitate the construction of a transmission line some fifty-five miles in length, The price contracted for power is $18.00 per horsepower per year, starting December 31, 1912. The company is capitalized at $5,000,000, and is represented by R. R. Muir, of Winnipeg, Manitoba.

At a meeting of the stockholders of the Saltcoats District Telephone Company which operates a telephone system in and around Saltcoats, Saskatchewan, it was decided to sell all that portion of the system lying beyond the town limits. A committee has been appointed to negotiate with the provincial government with that object in view.

The Calgary Power & Transmission Company, which is erecting a power plant at Kananaskis, Alberta, announces that it will be in a position to supply Calgary with power by April 1 of this year. The municipal plant being erected by Calgary on the Bow River will be put in operation on March 1 so there will be competing supplies for Calgary in the immediate future.

The Saskatchewan Government has arranged for the construction of a long-distance telephone line at once between Biggar and Saskatoon.

With a capital of $500,000 the Moosejaw Street Railway Company has been incorporated to build a street railway system in and about the City of Moosejaw, Saskatchewan. The promoters and provisional directors promise that work will be started at once. A. H. Dion, N. J. Ker and D. R. Street, all of Ottawa, Ontario, are named as the provisional directors.

The civic authorities of Edmonton, Alberta, have applied to the Dominion Government for power rights. In all 60,000 horsepower is asked for and the scene of development is Grande Rapids to the north of the city. Preliminary estimates show that the cost of the undertaking will be over $2,000,000. It is suggested that owing to the large amount of power available that the province develop the site and supply electrical energy to the cities and towns of Northern Alberta. At the next session of the Alberta Parliament the matter will be discussed.

The Winnipeg Electric Company has let the contract for its new power station in Winnipeg, Manitoba. It will have a maximum capacity of 17,000 horsepower and will be completed this summer. The generator will be driven by Curtis turbines and the equipment will be installed in four units. The Canadian General Electric Company will supply the machinery.

After looking over the system carefully the directors of the Northwestern Telephone Company, which owns and operates the telephone system in Saskatoon, Saskatchewan, the directors decided either to sell the plant to the provincial government or to greatly improve and extend it. J. C. Drinkle is managing director.

The Kaministiquia Power Company, which has a plant in the vicinity of Fort William, Ontario, has decided to spend $250,000 this year in enlarging its plant which is now working to capacity. Plans are being prepared and work will start as soon as possible. K.

COMMISSION NEWS FROM NEW YORK.

(Special Correspondence.)

A proposition for the construction, equipment and operation of a comprehensive municipally-controlled rapid-transit subway system has been submitted to the Public Service Commission by Dr. Joseph Caccabajo and Marshall W. Brown, engineers. The new proposal covers each of the five boroughs embraced in Greater New York. The proposal includes the triborough route with certain modifications, the Fourth Avenue subway route with its extensions in Brooklyn, the Richmond Borough route under the Narrows from Brooklyn to Staten Island, the Lafayette Avenue route with extension to Jamaica, and the new loop and tunnel to Fourteenth Street, Manhattan, through Bushwick Avenue and North Seventh Street, and Utica Avenue and other extensions in Brooklyn and extensions over the Queensboro bridge to Flushing, and the east and west Bronx extension to Lexington Avenue line. In addition, certain routes in Manhattan are provided in the new proposition. This includes the Second Avenue line, which the city may take at its option, making a part of the general plan.

The debt limit of the city will not be encroached upon and the city may take hold of the entire system at any time without embarrassment to its finances.

The company agrees to obtain money as needed for the construction and equipment of the various routes by selling preferred stock at a price which will net its par value to the treasurer of the company, which stock shall obligate the company to pay five-per-cent cumulative dividends for the four years of construction and equipment, of the first year of operation and thereafter ten-per-cent cumulative dividend.

The Public Service Commission, Second District, has had under consideration an application by the Geneva-Seneca Electric Company to purchase the electric plant of J. Q. Howe's Sons at Phelps, N. Y., and a further application for approval of agreement of consolidation proposed to be entered into by and between the

Geneva-Seneca Electric Company and the Wayne County Gas and Electric Company.

Hearings have been had, and after investigation the Commission has given preliminary consent to the consolidation of these several properties.

The Geneva-Seneca Company supplies electricity in the city of Geneva and villages of Seneca Falls and Waterloo.

The Wayne County Gas & Electric Company operates in the villages of Palmyra, Clyde, Newark and Lyons and supplies gas and electricity in each of these places, except in Clyde, where electric service only is furnished.

A complaint has been directed against the Upper Hudson Electric Company, alleging excessive prices for electricity. It is stated that the rate charged for commercial lighting in Coxsackie is fifteen cents maximum and a minimum monthly charge of $1.00, and for street lighting, $19.00 per arc lamp of twenty-five candlepower per year on the moonlight schedule. The complainants point out that the Upper Hudson Company operating at Coeymans and Ravena, which are approximately ten miles from the generating station at Coxsackie, has charged for the past three years six cents maximum with no minimum monthly charge, and has offered to furnish street lights to the unincorporated village of Ravena for $13.00 per lamp of thirty-two candlepower per annum, to burn all night long every night from dusk to dawn.

COMMISSION NEWS FROM MISSOURI.

(Special Correspondence.)

It is reported that the North American Company has obtained control of the Mississippi River Power Distribution Company which is to transmit power from Keokuk, Iowa, supplying the United Railways Company and the Union Electric Light & Power Company of St. Louis. These are both North American properties and this arrangement will make their relations with the Power Company closer than before. In this connection it is understood that the Union Electric Light & Power Company has taken over from the Laclede Gas Light Company the latter's contract with the Water Power Company for 4,000 horsepower, which contract runs for a period of ninety-nine years. This contract was made when the Laclede Gas Light Company was controlled by the North American Company. The Laclede Company has since decided to build its own power plant, which is at present under construction, located on the river at the foot of Mullanphy Street.

This additional contract gives the Union Company a ninety-nine-year contract for 64,000 horsepower with the Mississippi River Power Distribution Company.

The Public Service Commission of St. Louis, appointed in the Spring of 1909, has filed its report with the Municipal Assembly covering the investigation of the rates of the Union Electric Light & Power Company. This report is accompanied by an ordinance presented both to the House of Delegates and the City Council, fixing the maximum rate per kilowatt-hour at nine and one-half cents instead of twelve cents, the present rate. The ordinance also provides for filing with the Public Service Commission within six months after the approval of the ordinance, a complete printed schedule of rates to go into effect thirty days after being filed. It provides that meters shall be furnished free, but a maximum charge of $2.00 for the cost of installation is allowed. The above maximum rate includes free lamp renewals. The ordinance makes violation of its provisions a misdemeanor and provides a fine of not less than $50.00 nor more than $500.00 for each offense. It also covers the testing of all meters by the supervisor of city lighting, the fee of $1.00 for this service to be paid by the consumer if the meter is found correct within three per cent or slow, and to be paid by the company if the meter is found fast. The bills to be adjusted at once in accordance with the meter test.

The maximum rates are based upon a depreciation charge of five per cent and a net return of eight per cent above the depreciation charge on the appraisal valuation of the company's property as determined by the Public Service Commission. The appraisal value of the property is placed by the Commission at $17,857,000, which is nearly $10,000,000 below the valuation placed upon the property by the company's engineers. One of the large items regarding which the Commission and the company's engineers have differed is that of real estate, which the Commission has estimated as $700,000, while the company's estimate, based on the valuation of competent real-estate experts of the city is $3,450,000. The items of organization expenses, the cost of engineering, and the cost of building up the business are all items that have been estimated very much lower by the Commission than the valuation placed on them by the company. The Commission takes the position that the present maximum rate is too high, working a hardship upon the small consumer, and that some of the larger customers are being served at a rate that is too low and below a reasonable cost for the service. The Commission also criticises the present system of guarantees used by the company, on which the minimum monthly charge is based, this working a hardship in some cases, as claimed by the Commission, so that the consumer pays more than the present maximum rate of twelve cents per kilowatt-hour. The company, however, is given credit for taking steps to correct this evil of its own accord.

LIGHTING AND POWER.

(Special Correspondence.)

MENNO, S. D.—A franchise for an electric light plant has been granted to Peter A. Orth.

SNYDER, OKLA.—This city is about to vote on the issuance of $25,000 in electric light bonds.

FAIRVIEW, KANS.—Bonds to the amount of $3,500 have been voted here for an electric light plant.

FARMINGTON, MINN.—Mr. Larson has applied to the council for a franchise to install an electric light plant. C.

MOBRIDGE, S. D.—Smith & Hill have applied to the council for a franchise to install and electric light plant. C.

WHITE HALL, ILL.—J. W. Whitlock of this city has purchased the electric light plant at New London, Mo. Z.

BOLEY, OKLA.—The Boley Light & Power Company has filed notice of an increase of capital stock from $5,000 to $20,000.

ENDEAVOR, WIS.—The new lighting plant which is being built here is well under way and will be completed in a short time.

HUMESTON, IOWA.—It is proposed to take a vote on granting a franchise for the installation of an electric light plant. C.

NAPLES, TEX.—M. H. Sullivan, Jr., and Chas. E. Grant are making preparations to erect an ice and light plant in this city.

VIRGINIA, MINN.—The City Council has been petitioned to purchase the electric light plant and water plant or build a new one. C.

JACKSONVILLE, FLA.—The Jacksonville Electric Company is planning the construction of a power plant and pier to cost about $450,000.

ANDERSON, IND.—The City Clerk reports that the earnings of the municipal electric plant for last year amounted to $99,002 and the expenditures amounted to $45,587. S.

CALGARY, ALTA.—City Electrician O'Brien has petitioned the council for an appropriation for the improvement of the city lighting service. C.

MANISTEE, MICH.—On April 3 the voters will consider the proposition of voting $90,000 for the purpose of erecting a municipal lighting plant.

FREEPORT, ILL.—The Rigway Electric Company, and Baumgarten & Barnes Electric Company have purchased the property of the Union Electric Company.

DALLAS, S. D.—The Council has granted the Dallas Light, Heat & Power Company a franchise to construct and operate an electric light and power system. C.

CYNTHIA, IND.—A municipal electric light plant is being erected here, and $4,000 in bonds have been issued to meet the cost of construction work and equipment.

AUBURN, CAL.—The Placer County Board of Supervisors has approved of the plans of the Pacific Gas & Electric Company for the lighting of the Newcastle lighting district.

SANDOVAL, ILL.—Theo Fisher, of Greenville, has been granted a franchise to operate an electric light plant here. A new plant is to be completed within eight months. Z.

FREEPORT, ILL.—The Ridgeway Electric Company and the Baumgarten & Barnes Electric Company have purchased the electrical business of the Union Electric Company of this city. Z.

LENOIR, N. C.—It is said that the electric drive will be utilized by the Lenoir Chair Company as power for operating its new factory to replace the old one burned. L.

BOURBONNAIS, ILL.—The Kankakee Gas & Electric Company has asked for a new franchise in the village and also seeks a contract for lighting the streets of the municipality. Z.

TACOMA, WASH.—Work has been resumed on the Lake Tapps power plant, which was started some time ago by Stone & Webster. On injunction by the county caused the work to be interrupted.

STATESVILLE, N. C.—The Southern Power Company has cut in a second transmission line to this city via Gastonia and Hickory, making two lines which are now furnishing power to this place. L.

VALE, ORE.—The city will in a short time be connected with the lines of the power plant of the Telluride Power Association on the Malad River. The Malad River plant will be completed in March.

CLEVELAND, O.—The Whitney Power Company has been incorporated with capital stock of $50,000. The incorporators are Donald McBridge, T. M. Kirby, Ellis R. Diehm, C. Cowne Owens, and W. B. Whitney. Z.

HANNIBAL, MO.—The total cost of the enlargement of the electric light plant in Hannibal, which will be commenced soon will probably be $35,000, according to James P. Hinton of the board of public works.

BARRY, ILL.—The Barry Electric Light & Power Company has been organized by local interests. The officers are: President, Fred Frike; vice-president, W. I. Klein; secretary, A. R. Weeks; treasurer, John Weber.

lamps on Bennett Avenue was recently commenced. Ornamental lamp posts, four to a block, are to be used in connection with the 100-candlepower tungsten lamps.

BRIDGEPORT, ILL.—The Bridgeport Light & Power Company has been incorporated with a capital of $25,000 to furnish current for light, heat and power. The incorporators are R. D. Donnelly, W. E. Beyhan and V. H. Lytle.

SUMTER, S. C.—The plant and interests of the Sumter Ice, Light & Power Company have been sold to Philadelphia capitalists and although the consideration has not been made public a well authenticated report puts it at $150,000.

IMBODEN, ARK.—A lease on the electric lighting plant at this place has been secured from the People's Bank by J. Y. Philpot, who will begin the operation of the same at an early date. Imboden has been without lights for the past two months. I.

PEORIA, ILL.—Walter J. Spurck is active in a movement to have an ornamental lighting system installed from the Illinois River to Glen Oak Avenue. He proposes to have the property owners pay for the lamps and the city furnish the power. Z.

RICHMOND, VA.—Before the Committee of Electricity of the Council of this city, Alderman Bennett has secured a favorable report on his proposition to expend the sum of $9,000 to $15,000 per city block for ornamental lights to be built west from Broad Street to Elba station. L.

OGDEN, UTAH.—The construction of an electric generating station is being contemplated, although it is not decided whether steam or hydraulic power will be used. Already $20,000 has been guaranteed by local business men, and it is said that there is $1,000,000 behind the project.

SAUK CENTER, MINN.—Appropriations are asked by the Board of Control which governs the State Home for Girls here for a power plant, steam and electrical connections, amounting to $32,000. The sum of $72,000 is asked for a power plant and amusement hall at the sanitorium at Walker. Z.

ABERDEEN, S. D.—It is probable the town of Mobridge will soon be lighted by electricity. Two firms have made application to the City Council of the town for electric light franchises and the applications were referred to a committee. Tanner Bros., of Webster, and Hill & Smith, of Mobridge, are the applicants.

SANDUSKY, O.—The lighting question which for some time has been a prominent one here may be finally solved by the city supporting municipal ownership. A resolution has been adopted providing for an investigation of the municipal-ownership plan, with a view to submitting it to a vote of the people at a special election. H.

AUSTIN, TEX.—There is now a project under consideration to rebuild the $1,000,000 dam, which work was first undertaken by the Dumont-Holmes Steel Concrete Company, and later abandoned by them. The new offer comes from George D. Moore, of Detroit, Mich. He purposes to build the dam and install the hydroelectric plant for $1,000,000.

PLACERVILLE, CAL.—Engineers have begun the work of preparing a camp at Chili Bar, on the south fork of the American River, for the complete survey and platting of the power site ditch right and other interests under bond to the Sacramento and Sierra Railway Company. The engineers are under Civil Engineer J. A. Graham, of Berkeley.

PORTLAND, ORE.—President Josslyn, of the Portland Railway Company, announces that contracts for the third and the largest of his company's power houses will be let in a short time. The new location is on the Clackamas River, three miles above the present one in operation. It will have a capacity of 40,000 horsepower and will cost approximately $3,000,000.

PLEASANT HILL, ILL.—The Emert Manufacturing Company expects to have its electric light plant here in operation by March 15 and later will extend to Nebo and surrounding towns. Two 100-horsepower boilers and a 125-horsepower Hamilton Corliss engine have been installed. J. H. Emert, of Peoria, is vice-president of the company, which is capitalized for $30,000. Z.

LYNDON, ILL.—Edward S. Smith, Harvey S. Green and John J. Hurlburt, granted permission in a bill now past the lower house of Congress to build a power dam across the Rock River at Lyndon, announce that they have succeeded in securing nearly all the overflow rights, and, if the measure is passed by the Senate, will begin construction at once. Plans are made to supply current to Morrison, Prophetstown, Erie, Lyndon and possibly Tampico. Z.

CALUMET, MICH.—The water power plant at the falls of the Au Train River near Dixon is practically completed, and as soon as the transformers at Munising are installed, the machinery will be put in operation. The current will be used at the Munising paper mill, thirteen miles distant. At present the paper mill is operated by electricity, generated entirely by steam. It is estimated that the water power at Au Train will yield 250 to 800 horsepower.

TURNER, ORE.—The Turner City Council has voted a franchise to the Interior Warehouse Company, a branch of Balfour, Guthrie & Company, of Portland, to install a plant for furnishing electric lights to Turner. The Company furnished a bond for $2,000 to guarantee its good faith and must under the terms of the franchise complete the plant inside of ninety days. The poles and wire have already been ordered. The question of erecting ornamental lamp posts along the principal streets of Turner is being considered.

GADSDEN, ALA.—At a recent meeting of the City Council, Engineer J. N. Hazelhurst made a complete report to that body on the present condition of the new water plant and what it will cost to complete the system according to the plans and specifications which were adopted. According to the engineer's report, not more than $15,000 in excess of the available funds are needed. Altogether, something under $50,000 will be required to complete the system. The system will be completed within about four months. I.

RICHMOND, VA.—This city is at present facing a rather peculiar problem as to the wiring of the handsome City Hall and Municipal Building, erected and wired in 1894. The city is completing its municipal electric plant, and will soon have its own power for all purposes, but as the building was wired in 1894, engineers declare that this wiring could scarce pass muster and is now obsolete, so that the installing of a new system or the entire overhauling of the old one would be necessary if electricity were used, gas having furnished illumination for the past seventeen years. It is further said the cost of rewiring the building will be about $5,000. Detailed estimates together with plans for the completion of this work will likely be called for shortly. L.

ATLANTA, GA.—The Georgia Power Company has let the necessary contracts for another power plant to be located at Tallulah Falls, Georgia, the same to be completed during 1912, furnishing 100,000 horsepower. A dam 100 feet in height is to be built at the site, and six generators of 15,000 horsepower capacity and the remaining requisite machinery will be installed as early as possible. The water is to be carried through a tunnel for and and one-quarter miles through which it is said a 600-foot drop will be secured. The Northern Contracting Company, of New York, and Detroit, Mich., has secured most of the contracts. The Georgia Power Company has at its command sites which will with Tallulah Falls, Georgia, the same to be completed during 1912, will not be developed until the demand arises. L.

ELECTRIC RAILWAYS.

(Special Correspondence.)

FRUITVALE, CAL.—The plant of the Southern Pacific Company was put in operation on February 9. The plant will furnish power to interurban railways lines.

GREENVILLE, TEX.—The special track for the electric street car line being built in this city has begun to arrive and work will now be pushed on laying the track.

PHILADELPHIA, PA.—Plans are said to have been perfected for the extension of the trolley line from Skippack to Schwenkville and thence to Green Lane and Pennsburg.

EVELETH, MINN.—The surveys for the electric road between Eveleth, Gilbert and Virginia have been completed and the promotors are now securing franchises in the cities in which they will operate.

SAN ANTONIO, TEX.—A. D. Powers has bought the unfinished street railway that J. A. Logwood, P. A. Vance and G. A. Waro started to build along the Corpus Christi Road to San Jose and the Terrell Well.

TUCSON, ARIZ.—Definite announcement that the El Paso and Southwestern will extend its line to Tucson was made to the Railroad Committee of the Chamber of Commerce by Prof. James Douglas and Walter Douglas.

KENDALLVILLE, IND.—J. M. Kinney, a well known railroad contractor, is promoting a traction line from Kendallville to Goshen by way of Albion and Ligonier. The people are enthusiastic over the prospects of the road and will render aid. S.

CAREY, O.—Announcement is made that the Marion & Toledo electric line will be extended to Upper Sandusky, and thence on to Toledo in the near future. Frank M. Ohl, Toledo promoter, has asked the people of Sycamore to take $15,000 in mortgage bonds of the company. H.

LAPORTE, IND.—The Chesterton-Laporte electric line has been completed and opened for service by the Air Line Traction Company. The next link to be constructed is between Goodrum and Flint Lake. The purpose is to build as speedily as possible on to Gary and Hammond and ultimately to Chicago. S.

ATCHISON, KANS.—The passage by the United States Senate of the bill authorizing a bridge across the Missouri River at Atchison is the first step in the building of the electric railway from Atchison to St. Joseph and from Atchison to Leavenworth, there to connect with the Kansas City Western into Kansas City.

FRESNO, CAL.—Fresno, Monterey and Coalinga capitalists have launched a project for the building of an electric line from the Coalinga oil fields of California to the port of Monterey. It is expected that this line will result in the more general de-

velopment of the Coalinga district, the largest oil-producing field in California.

DANVILLE, IND.—John W. Trotter, head of the Capital Circuit Traction Company, announces that work will be begun soon on the first section of the road which, when completed, will connect Danville and Lebanon. The company proposes to build a traction line encircling Indianapolis, connecting eight or ten county seat towns in contiguous counties, each being about twenty-five miles distant from Indianapolis. S.

CRESTON, IOWA.—The stockholders and board of directors of the Creston-Winterset interurban have filed articles of incorporation authorizing a capital stock of $500,000 to build the road from here to Des Moines. The old officers were re-elected: R. B. Brown, president; Clarence Wilson, first vice-president; M. E. Harris, second-vice president; A. S. Lynn, secretary, and W. W. Walker treasurer.

ATLANTA, GA.—Formalities attending the beginning of the building of the electric line from Fairburn to Atlanta, were held recently, and a gold spike was the first driven in the first rail of the road that will connect the two cities. W. T. Roberts is president of the new line, and Col. J. F. Golightly is secretary. The capital stock was subscribed by citizens of Fairview, Union City and contiguous territory. L.

SOUTH BEND, IND.—The officials of the South Bend and Northern Indiana Railway held their annual meeting here and considered many important improvements to the city and interurban lines. Some new lines and new cars and some extensions on the interurban lines were decided on. The meeting was attended by Charles F. and Alfred E. Dietrich of New York and Charles and Samuel Murdock of Lafayette. S.

MINNEAPOLIS, MINN.—Preliminary announcement of proposed improvements for 1911 by the Minneapolis Street Railway Company has been made by Willard J. Hield, vice-president. So far as approved by the directors, these will include completion of the addition of fifty per cent to the power generation at the steam plant on the east side, more boiler capacity, better stoking equipment and prevention of smoke, additional wiring, two new sub-stations and track work. The cost will probably exceed $1,000,000. Among the improvements already settled upon by the street railway company is the completion of work begun last year on the installation of a 14,000-kilowatt steam-turbine unit.

RICHMOND, VA.—The new 2,600-foot viaduct of the Richmond and Henrico Railway Company, in this city, has been completed, and thrown open to the public. The outlook is favorable for the starting up of electric cars over the viaduct by the middle of April. The viaduct is ninety-six feet in height and forty-two feet in width. The question is now being agitated whether the new cars shall use municipal power or their own electric power in the operation of the lines over Broad Street, one of the chief thoroughfares of the city. The company, it is said, desires, after having invested a large sum in its own generating plant, to install its own trolley, while the city is insisting that the company use the city's wires. L.

TELEPHONE AND TELEGRAPH.

(Special Correspondence.)

RAPID CITY, S. D.—The Nebraska Telephone Company will put in a new and modern exchange. C.

HOOKER, OKLA.—The Farmers Mutual Telephone Company has been incorporated with a capital stock of $1,500.

LONE WOLF, OKLA.—The Lone Wolf Rural Telephone Company has been incorporated by Cash McIlwain and others.

GENEVA, O.—The People's Telephone Company, with a capital of $10,000, has been incorporated by C. I. Crowthers and others.

MAZOMANIE, WIS.—The Mazomanie Telephone Company will build a new line to Marxville and Dunlap Valley as soon as possible.

BEMENT, ILL.—The Piatt County Telephone Company will erect a new two-story building to house its exchange and general offices. Z.

BUSHNELL, ILL.—F. W. Copeland and A. L. Florey have city for a twenty-five year franchise to operate a telephone exchange. Z.

WALPELLO, IOWA.—The Iowa Telephone Company is planning the expenditure of $8,000 for improvements to its telephone building. C.

LADYSMITH, WIS.—The Chippewa Valley Telephone Company is planning extensive improvements to its service this coming season. C.

CULLOM, ILL.—The Cullom Mutual Telephone Company will incorporate with F. W. Kingdon, Martin Dewiler and Daniel Gales as incorporators. Z.

JENNINGS, LA.—J. W. Boyers of this place has traded property valued at $35,000 for the telephone plant and other property at West Plains, Mo. Z.

FERGUS FALLS, MINN.—The Friberg Co-operative Telephone Company, E. W. Leeper, Secretary, has been organized to run six lines into this city. C.

TUSCOLA, ILL.—The Tuscola Telephone Company has opened a new metallic-circuit toll line connecting with points in Indiana, Ohio and Kentucky.

WARDEN, WASH.—The city telephone line is now complete and the telephones are being installed. The line connects with a number of rural lines.

AVERYVILLE, ILL.—The Central Union Telephone Company has been granted a twenty-year franchise, all wires to be placed underground within a year. Z.

BACKUS, MINN.—The Backus Rural Telephone Company has incorporated with a capital of $10,000. The incorporators are J. W. Bailey, O. A. Miller, and Lawrence Dougherty.

CLIFF TOP, W. VA.—The North Fayette Telephone Company was recently incorporated with a capital of $5,000. The incorporators are R. L. Walker, John E. Hugart and B. H. Myles.

EPPING, N. D.—The Epping Telephone Company has been incorporated with a capital of $25,000. The incorporators are Ole Ellingson, C. F. Carpenter, C. O. Odell and R. L. Hambleton.

OROFINO, IDAHO.—A telephone line will be built in the spring to the interior country to tap the Red's prairie section and extend as far east as Big Island, thirty miles from Orofino.

NEWVILLE, W. VA.—The Newville Telephone Company has been incorporated with a capital of $5,000, by Jesse Skidmore, G. W. McQuinn, J. M. Harper, A. M. Douglas and B. H. Adkison.

CHENOWETH, N. D.—J. F. Dilse, president, and Edward Feldhuson, treasurer of the Midway-Stillwater Telephone Company, intend to install a telephone line from Scranton to Chenoweth.

ALEXANDRIA, LA.—New material has been ordered for the exchange of the Cumberland Telephone Company here, and the system will be changed to a central-energy installation.

CHESTNUT, ILL.—The Chestnut Mutual Telephone Company has been incorporated with capital stock of $1,500. The incorporators of the company are George F. Dittus, W. H. Donnan and F. A. Molterman. Z.

NACOGDOCHES, TEX.—Chireno, an inland town in this county, reports another telephone line, making the third now for that village. All three are owned and operated by different concerns.

FOND DU LAC, WIS.—Plans are being considered for the consolidation of the Fond du Lac Rural Telephone Company and the Empire Telephone Company. The former has a capitalization of $20,000.

HECLA, NEB.—The North Hecla Telephone Company, recently organized, puts into connection with this place all of what was known as the old "101" Ranch north of here. C. Revere is president of the company.

BRITTON, OKLA.—The Britton Telephone, Telegraph & Electric Company has been incorporated with capital stock of $3,000. The incorporators are G. E. Crawford, S. S. Shantafferm, W. H. Dye, E. S. Rose, W. C. McGrew and G. W. Riley. Z.

ROCKFORD, ILL.—Charles F. Tritle, H. Hicks and Arthur Simpson, representing the Winnebago County Telephone Company, have purchased a controlling interest in the Burritt Telephone Company and will consolidate the exchanges. Z.

MARSHALLTOWN, IOWA.—The Merchants, Mechanics & Farmers Telephone Company is planning the erection of an exchange and the installation of an automatic plant. Work will be started about March 1. The cost is to be $100,000.

DEADWOOD, S. D.—It is reported that the Nebraska Telephone Company will spend more than $100,000 this year for improvements and extensions in the Black Hills. About $85,000 will be spent for new work, the remainder going for improvements commenced last year.

PERSONAL MENTION.

D. McFARLAN MOORE recently gave a lecture before the department of electrical engineering of Columbia University.

F. W. KELLEY, of Aurora, Ill., has been made manager for the Central Union Telephone Company's properties at Galesburg, Ill.

ROBERT MATHER of the Westinghouse Electric & Manufacturing Company was in Chicago this week on a business trip.

A. E. PETERS, of Detroit, has been elected secretary of the Detroit United Railway to succeed Edwin Henderson, of New York.

W. GODFREY BOYD, manager of the sales department of Lamont, Corliss & Company has resigned in order to become manager of the sales department of the New York Incandescent Lamp Company.

GEORGE T. HEWES, of Des Moines, Iowa, has been made manager of the Independent Telephone Company of Council Bluffs, Iowa, succeeding C. A. Laubach, who retires to engage in other business.

EDWARD O. REED, of Toledo, O., has accepted the position of auditor of the Western Ohio Electric Railroad Company. He will assume his new duties on March 1. His headquarters will be at Lima, O.

Friday, February 24. The address was illustrated by numerous interesting lantern slides.

ARTHUR P. PIERSON, who has for the last five years been identified with the general electric supply business, has been appointed exclusive agent for New York and vicinity, for the Brilliant Electric Company of Cleveland, O.

SAMUEL A. HOBSON, formerly with the Wesco Supply Company, has been appointed manager of the St. Louis office of the Fort Wayne Electric Works. Mr. Hobson's business address will be 1311 Chemical Building, St. Louis, Mo.

G. C. EMMONS presented a paper on "Frequency Converter Sub-Stations" before the Armour Institute of Technology branch of the American Institute of Electrical Engineers, Chicago, on February 16. The meeting was held in the engineering rooms of Chapin Hall.

A. C. DODGE, superintendent of the telephone apparatus shops of the Western Electric Company, Hawthorne, Ill., addressed the Telephone Society of New York at its one-hundred-and-twenty-fifth meeting on February 20. Mr. Dodge's subject was "The Manufacture of Telephone Apparatus."

E. D. BRIGHT, special representative for the Connecticut Telephone & Electric Company, of Meriden, Conn., will in the future take care of Eastern territory for the Connecticut Company. Wm. H. Lolley of the Remy Electric Company will in the future cover the Detroit territory previously taken care of by Mr. Bright.

FREDERICK H. MILLENER, experimental electrician of the Union Pacific Railroad Company, at Omaha, Neb., delivered an illustrated lecture on "The Application of Wireless as an Adjunct in Operation of Railroads," under the auspices of the Engineers' Club, before the members of the New York Railway Club, on February 17.

J. B. McCRARY, president of the J. B. McCrary Company, of Atlanta, Ga., was presented a handsome gold watch chain by his engineers and superintendents, following a banquet given by him on December 29. Mr. McCrary's company has done a great amount of work in the way of industrial development, not only in Atlanta but through the entire South.

S. O. OCHS, of the Russian Importing Company, Boston, Mass., sailed for Russia on the *Kaiserin Auguste Victoria*, February 11. Mr. Ochs represents several American manufacturers of electrical and other apparatus which is being introduced to the Russian public. For the next few months his address will be care of Russian Importing Company, Morskaia 21, St. Petersburg.

J. H. COOKE, manager of the Chicago office of the Buckeye Electric Company, Cleveland, O., who, for a number of weeks has been resting at Hot Springs, Ark., reports that he is rapidly regaining his strength and will return to Chicago in a short time. During Mr. Cooke's absence D. H. Wyre, newly appointed assistant manager, has been in charge of the Chicago business.

W. W. MOORE, who has been in the employ of the Wesco Supply Company, of St. Louis, for the past nine years in various capacities, from that of traveling salesman to manager of the Birmingham branch, has resigned from its service to open an office for himself in the Empire Building, Birmingham, Ala. Mr. Moore, in addition to to his work as consulting and constructing engineer, especially along water and electric lighting plant lines, for which he is peculiarly well fitted, both by training and experience, will also act as manufacturers' agent for several lines of mine supplies and machinery.

CAPT. B. S. BARNARD.

CAPT. B. S. BARNARD, one of the best known and most popular men in the conduit field, and who for fifteen years past was active in the management and official life of the Standard Vitrified Conduit Company, has purchased an interest in the Clermont Sewer Pipe Company, of Clermont, Pa., and will hereafter devote himself to the duties of vice-president of this company. He retired from the Standard Vitrified Conduit Company the first of last month, and now has his office at 50 Church Street, New York. The Clermont Sewer Pipe Company is well equipped with clay and coal mines, the plant being located in Western Pennsylvania. Since January 1, 1911, of the five or six most important orders for conduit placed in the East, Captain Barnard has closed every one of them for the Clermont Company.

OBITUARY.

WILLIAM KENNEDY FLEMING, who was for the last eleven years private secretary to Judge Gary, Chairman of the Board of Directors of the United States Steel Corporation, died February 17 at the Edgemere Hotel, East Orange, N. J., of pleuro pneumonia. Mr. Fleming was forty-six years of age and a native of Brantford, Ontario, Canada. He was a graduate of Harvard. He is survived by Mrs. Fleming and two sons.

INDUSTRIAL ITEMS.

THE MINNEAPOLIS STEEL & MACHINERY COMPANY, Minneapolis, Minn., has just issued its stock list for the month of February. The company lists a large amount of power machinery and appliances.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, O., manufacturers of incandescent lamps, has moved its Chicago office from 23 East Lake Street to 100 East Lake Street. The change was made on account of the demands of the Chicago branch for larger quarters, due to an increasing volume of business.

THE FRANKS MANUFACTURING COMPANY, Rock Island, Ill., describes and illustrates the Franks adjustable electric-light fixtures in a little pamphlet which was distributed recently. The adjustable feature of these fixtures is a ball seated between the base of the fixture and a tensioned plate, so that the action is something like that of a ball-and-socket joint.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has issued the second edition of bulletin No. 1120 on electric rock drills. This bulletin contains a description of the drill and enumerates its many advantages. Tests indicate that this drill requires only one-tenth of the power necessary for an air drill of the same capacity. Copies of this bulletin can be had upon application to the office at Madison, Wis.

THE ANDERSON ELECTRIC CAR COMPANY, Detroit, Mich., has published an attractive and artistic catalog on its 1911 cars. The new models are shown by full-page illustrations, and in addition to these a number of photographs taken throughout the different departments of the factory are included. Prices are given for all cars equipped either with the standard lead battery or the Edison battery.

THE FEDERAL ELECTRIC COMPANY, Chicago, Ill., makes especial mention in the February issue of *The Federalist*, of its exhibit at the Chicago Electric Show. An illustration of one of the new Federal Electric kitchen cabinets which were exhibited there, gives an excellent idea of the compactness and convenience of this device. This is described more fully in Bulletin No. 540, which the company will mail to those interested.

STROMBERG-PARKSON TELEPHONE MANUFACTURING COMPANY, ROCHESTER, N. Y., has purchased the American Electric Telephone Company's entire common battery business, with all inventions, tools, patents, etc., and will considerably extend its business. In order to augment the engineering staff and to give the best service possible, the company has employed Henry P. Clauson, who was formerly chief engineer of the American Electric Telephone Company.

THE HEMMING MANUFACTURING COMPANY, on account of the rapid growth of its business, has found it necessary to double the output capacity of its factory, and in order to handle this business to better advantage has moved its main offices to the factory at Garfield, N. J. B. H. Howell, president of the company, will have immediate charge at the main office and factory. The sales offices of the company will be continued at No. 2 Rector Street, New York City, in charge of Butler Keyes, general sales manager, who will be pleased to meet his friends and customers at this address.

THE MOLONEY ELECTRIC COMPANY, of St. Louis, Mo., has recently secured a contract from a Canadian electric railway for transformers costing $268,000. To handle this business and properly to take care of its other Canadian interests, the Moloney Company is now establishing headquarters in Windsor, Ont. A factory measuring 120 by 200 feet is now being built, which will be completed in sixty days. About fifty hands will be employed at the start. The structure will be one story, and will be built adjoining the tracks. It will have a twenty-ton traveling crane which will run from one side of the factory to the other.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, Pittsburg, Pa., has received a number of foreign orders lately, among which is one for a 150-horsepower alternating-current motor for use in a Chinese flour mill. The Chinese Government has also ordered two 150-kilowatt direct-current generators and a switchboard. The generators will supply power to the Bureau of Engraving at Pekin. The San Juan Light & Transit Company of Porto Rico has ordered seven thirty-kilovolt-ampere, single-phase, sixty-cycle, 1100-110-220-volt type "S" transformers; five twenty-five-kilovolt-ampere, single-phase, sixty-cycle, 1100-110-220-volt type "S" transformers, and a total of 200 horsepower in small back-geared "HF" and "CCL" motors for a machine shop.

DATES AHEAD.

American Physical Society. Next regular meeting, New York City, March 4, 1911.

Minnesota Electrical Association. Annual convention, St. Paul Hotel, St. Paul, Minn., March 14, 15 and 16.

National Electric Light Association. Annual meeting of New England Section, Edison Building, Boston, Mass., March 17.

American Supply and Machinery Manufacturers' Association. Annual meeting, Louisville, Ky., April 3, 4 and 5.

American Electrochemical Society. Annual meeting, Chemists' Club Building, New York, N. Y., April 6, 7 and 8.

Missouri Electric Gas, Street Railway and Water Works Association. Annual meeting, St. Louis, Mo., April 13, 14 and 15.

Iowa Electrical Association. Annual meeting, Davenport, Iowa. April 19, 20 and 21.

Southwestern Electrical and Gas Association. Annual convention, Houston, Tex., April 27-29.

Mississippi Electric Association. Annual convention, Gulfport, Miss., June 20-21.

RECORD OF ELECTRICAL PATENTS.

Issued (United States Patent Office) February 14, 1911.

983,881. MAGNETIC SEPARATOR. Alvin Dings and Myron Dings, Milwaukee, Wis., assignors to Dings Electro-Magnetic Separator Co., Milwaukee, Wis. Filed March 16, 1905. A conveyor has an electromagnet mounted above it but between it and the magnet is a rotary carrier with auxiliary pole pieces.

983,898. RINGING-KEY. Elbert R. Hobbs, Bubl, Idaho. Filed January 23, 1908. An operator's ringing outfit comprises a cord circuit and plug, a master key, a number of selective keys, and means whereby the master key after selection may apply the selective ringing current to either side of the cord.

983,899. AUTOMATIC TELEPHONE-SELECTOR OR RINGING DEVICE. Roe R. Hobbs, Louisville, Ky. Filed Aug. 11, 1909. A polarized magnet has its armature indirectly connected to a ratchet wheel.

983,905. TELEGRAPH-SOUNDER. Harry T. Johnson, New York, N. Y. Filed June 25, 1908. Switches are arranged between the magnet coils and the sounder terminals so that the coils may be connected in series or in parallel.

983,908. ELECTRIC SWITCH. Fridolin W. Kurtz, New York, N. Y. Filed October 12, 1909. A set of concentric contact rings is connected to different lamp circuits. A rotating switch arm makes contact with the rings.

983,931. DETINNING AND GALVANIZING SCRAP. Alexander S. Ramage, Newark, N. J., assignor to John H. Maugham, trustee, July 3, 1909. The cyclic method of treating waste lead products in scrap and galvanized scrap by first dissolving in caustic soda, then precipitating the spongy lead by means of tin scrap, thus detinning the scrap and forming stannate of soda, then treating that solution with galvanized scrap, thus dezincing the scrap and forming zincate of soda, then partially electrolyzing the zincate of soda thereby obtaining metallic zinc and a resulting liquor containng zincate of soda and an excess of caustic soda, which is again employed for treating the lead product.

983,932. MAGNETO-ELECTRIC GENERATOR. Frank I. Remy and Benjamin P. Remy, Anderson, Ind., assignors to Remy Electric Company, Anderson, Ind. Filed March 20, 1909. Is provided with an integral casing which has bearings set in from the inside.

983,933. AUTOMATIC PRESSURE-GOVERNOR. Walter J. Richards, Milwaukee, Wis., assignor to National Brake & Electric Co., Milwaukee, Wis. Filed June 29, 1907. Connected with a pressure gage on contacts for controlling the current to the motor that drives the air pump.

983,943. ELECTRIC HAMMER. Reuben S. Smith, Marshall, Tex. Has two axially adjacent solenoids with a reciprocating plunger whose active stroke is under the control of the operator through a set of stationary and movable contacts.

983,949. MAGNETICALLY-CONTROLLED POWER-TRANSMISSION MECHANISM. August Sundh, Yonkers, N. Y. Filed August 5, 1909. An automobile transmisison set includes a series of gears whose connection is affected by electromagnets.

983,966. TELEPHONE TESTING SYSTEM. Charles S. Winston, Chicago, Ill., assignor to Kellogg Switchboard & Supply Co., Chicago, Ill. Filed May 9, 1907. Combined with the testing strand of a cord circuit is an impedance, a condenser and an induction coil and means for discharging the condenser when a busy line is tested.

983,976. MOTOR-CONTROLLING DEVICE. Charles E. Carpenter, New York, N. Y., assignor to Cutler-Hammer Mfg. Co., Milwaukee, Wis. Filed May 9, 1907. A relay-controlled motor switch has bridging contacts mounted on a spindle with a set of spiral springs.

983,979. AUTOMATIC ELECTRIC IGNITER FOR ORCHARD-HEATERS. Thomas Chapman, Denver, Colo. Filed January 13, 1909. A set of receptacles containing fuel has covers tending to open but held closed by fusible links in an electric circuit. Wicks connect with the fuses so as to ignite the fuel at the same time.

984,008. ELECTRIC SELF-WINDING CLOCK. Walter H. Kallenbach and Charles C. Bertsch, Boston, Mass. Filed October 26, 1909. An electromagnet acts indirectly on the escapement.

984,011. PROCESS OF ETCHING BY ELECTROLYSIS ON RELIEF OR INTAGLIO. Albert D. Lapointe, Sioux City, Iowa, assignor to Bastian & Lapointe, Sioux City, Iowa. Filed June 6, 1910. Consists in applying a current of electricity to prints of zinc, copper or brass, placed in a solution of a nitrate salt of the metal used.

984,016. VACUUM-TUBE. Daniel McFarlan Moore, East Orange, N. J., assignor to Moore Electrical Co., New York, N. Y. Filed March 17, 1910. The combination of a Moore vacuum tube with gas-feeding means operable to feed gas to the tube in a given position of the tube, and which prevents feed of the gas in other positions of the tube.

984,053. PULL-SOCKET FOR INCANDESCENT ELECTRIC LAMPS. August Weber, Sr., Schenectady, N. Y., assignor to Weber Electric Co., Schenectady, N. Y. Filed March 21, 1908. A switch operating member projects from one side of the socket so it can be operated by a pull-chain.

984,068. BATTERY-BOX. Arthur H. Brandon, Toledo, Ohio. Filed January 12, 1910. A box for dry cells has spring fingers mounted on its cover so as to engage the cell terminals and connect them in series.

984,088. AUTOMOBILE-LAMP. Charles W. Harris, Salem, Conn. Filed November 15, 1909. A box-like casing with transparent sides has an electric lamp at one end.

984,090. TREATMENT OF GOLD-BEARING ANTIMONY ORES. John Jones and Horace Sandford Bohm, Shandon Hill, Mount Morgan, Queensland, Australia. Filed May 18, 1910. Consists in subjecting the pulverized ore to the action of hydrochloric acid while being heated and agitated, purifying the solution and electrodepositing antimony therefrom, eliminating free chlorine from the spent electrolyte, and utilizing the solution for the treatment of further bodies of ore.

984,095. STORAGE-BATTERY TANK. Hugh Lesley, Philadelphia, Pa. Filed June 16, 1910. The lead lining is bent over and outward from the top of the tank and its edge is angularly cut and turned into the form of gutters with holes at the lowest points so as to direct the acid drip.

984,097. TERMINAL. Carl E. Lundgren, La Crosse, Wis., assignor to Vote-Berger Co. Filed July 5, 1907. A plug terminal connection.

984,108. APPARATUS FOR DETERMINING THE DIRECTION OF SPACE-TELEGRAPH SIGNALS. Oscar C. Roose, Cambridge, Mass. Filed April 15, 1909. Comprises two separated aerials means in each for compensating for phase difference between the oscillations, a receiving circuit associated with each, and an oscillation detector asociated wtih said receiving circuit.

984,119. ELECTRIC FURNACE. Howard I. Wood, Schenectady, N. Y., assignor to General Electric Co. Filed July 2, 1906. The combination of an evacuated chamber, a heater of carbonaceous material therein and a closed charge-protecting envelope therein but out of contact therewith, and consisting of a refractory compound that has high affinity for carbon.

984,125. COMMUTATOR. William A. Dick, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Co. Filed Sept. 20, 1906. Has a clamping ring and a number of rings interposed between the clamping ring and the cylinder segments, some of which are severally provided with an outer flange at one side and an inner flange at the other side.

984,128. ELECTRIC-LIGHTING SYSTEM. Ervin M. Fitz, Columbus, Ohio. Filed Feb. 13, 1909. A tungsten-lamp circuit has an auxiliary circuit connected to it to keep a low current flowing through the lamps when not in use so that the filaments are not brittle.

984,129. INSULATING-TUBE. Charles Le G. Fortescue, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Co. Filed June 9, 1910. Has a number of telescoping sections, each comprising alternate layers of insulating and conducting materials.

984,130. WATERPROOF ELECTRICAL SOCKET. Edgar H. Freeman, Trenton, N. J. Filed Nov. 30, 1910. Is protected by a two-piece porcelain cover.

984,136. HOLDER FOR GLOBES OF LIGHTING APPARATUS. John H. Goss, Waterbury, Conn., and John Weber, Schenectady, N. Y., assignors to Weber Electric Co., Schenectady, N. Y. Filed Oct. 12, 1910. A globe-clamping wire has adjacent movable end portions and an intermediate bent part, the ends being operated by a cam lever.

984,143. PROCESS OF MANUFACTURE OF TUNGSTEN DIOXID. Anton Lederer, Vienna, Austria-Hungary, assignor to Westinghouse Lamp Co. Filed Sept. 6, 1907. Consists in intimately mixing the higher oxides of tungsten with a proper proportion of glycerine and then subjecting the mixture to a high temperature.

984,154. ELECTRICAL SIGNALING AND ALARM APPARATUS. Clark H. Pool, New York, N. Y., assignor to International Elec-

tric Protection Co. Filed Nov. 8, 1910. Consists of a thermostat and alarm circuit actuated by sudden rise of temperature, but not actuated when a low test current is applied.

984,156. INSULATING STRUCTURE. Arthur B. Reynders and Jesse E. Mateer, Wilkinsburg, Pa., assignors to Westinghouse Electric & Manufacturing Co. Filed May 13, 1910. An insulated lead structure comprises concentric conductors, separating insulating tubes of graded lengths to form a series of steps, and overhanging metal skirts supported upon the steps and connected electrically to the ends of the conductors.

984,160. METHOD OF TESTING ELECTRIC TRANSFORMERS. Maurice C. Rypinski, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Co. Filed Dec. 6, 1907. Consists in supplying current to its primary and to the primary of a standard transformer connected in parallel, adjusting the polarity of the two transformers and supplying current from both through resistances to an indicator that is sensitive to phase reversals, and adjusting the secondary voltage of the standard transformer to balance the voltage of the transformer under test.

984,175. LIGHTNING-ROD. Charles E. Yarian, Galion, Ohio. Filed March 7, 1910. The rod ends in a specially constructed ground pipe.

984,182. MAGNETIZABLE WEDGE FOR DYNAMO-ELECTRIC MACHINES. John M. Barr, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Co. Filed Aug. 2, 1909. A coil-retaining wedge for open-slot machines comprises a yielding iron bar of channel shape and a non-magnetizable wedge which is adapted to be forced into the iron bar to expand it after it is placed in positon.

984,191. TIME-SWITCH. Charles E. Campbell, Lynn, Mass. Filed Oct. 31, 1908. A hand on a clock dial operates a spring switch through a tripping device.

984,202. SELECTIVE SIGNALING SYSTEM. John Erickson, Chicago, Ill., assignor to First Trust & Savings Bank, trustee, Chicago, Ill. Filed Aug. 16, 1905. A couple of generators connected in series and grounded at a point between the two machines send current over two lines when any one of a number of signaling keys is depressed. Each signal-receiving means comprises a polarized ringer, and a magnet which is energized to prevent the bell from ringing, the operating circuit of at least one signal-receiving means including the bell in series with a winding of its associated magnet.

984,203. SELECTIVE SIGNALING SYSTEM. John Erickson, Chicago, Ill., assignor to First Trust & Savings Bank, trustee, Chicago Ill. Filed Aug. 16, 1905. Current is furnished by two synchronized alternating-current generators grounded at a point between them. Each signal-receiving means comprises an electric bell or ringer a normally-closed shunt or short-circuiting connection extending around the ringer, and means for automatically opening up the shunt or short-circuiting connection when the bell is to be rung.

984,204. LOCK-OUT FOR PARTY-LINE-TELEPHONE SUBSCRIBERS' STATIONS. John Erickson, Chicago, Ill., assignor to First Trust & Savings Bank, trustee, Chicago, Ill. Filed April 16, 1906. The switch hook operates the switch springs and an electromagnet provided with an armature co-operates with the switch hook in controlling said switch springs. The springs are not operable by the switch hook except when the magnet is energized.

984,211. ELECTRICAL ALARM SYSTEM. Albert Goldstein, New York, N. Y., assignor to International Electric Protection Co. Filed Aug. 6, 1910. The alarm circuit is combined with an ordinary telephone circuit. Means are provided for indicating any trouble on the protective circuit. There is in addition a separate alarm circuit, means for connecting to line either the translating devices or the alarm circuit, and in the alarm circuit are means for receiving signals and means for transmitting signals.

984,218. SELF-WINDING ELECTRIC CLOCK. Robert L. Hight, Decatur, Ill. Filed Sept. 10, 1909. The clock is provided with an electromagnet, which actuates a ratchet, thus winding the main spring of the clock.

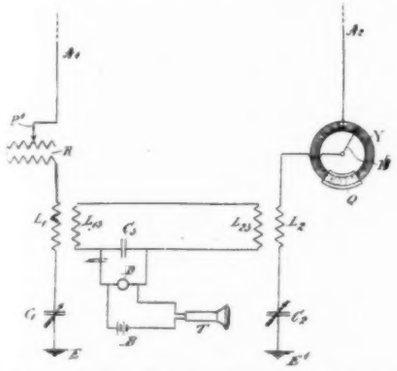
984,224. ELECTRIC TAPLET. Nathan Klein, New York, N. Y. Filed Dec. 16, 1909. The taplet is provided with longitudinal grooves, one of the leads being brought under the groove in which the other wire runs.

984,235. TELEPHONE SYSTEM. Arpád Németh, New York, N. Y., assignor to United States Telephone Herald Co., Wilmington, Del. Filed Aug. 20, 1910. Combines a number of telephone transmitters, and means for controlling the operative circuit of any one of the transmitters from the central station. A number of transformers can be used for progressively increasing the potential. A plurality of substations are associated with the receiver-circuit and means are associated with each substation for decreasing the current potential uniformly with respect to each substation, whereby the reproductions at the substations are rendered uniform in volume and character.

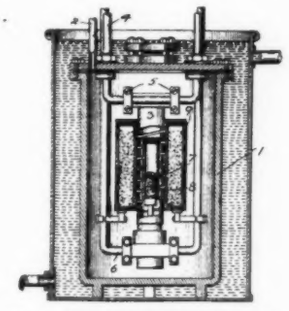
984,238. SWITCH. Granville E. Palmer, Winchester, Mass. Filed June 25, 1910. A reversible face plate has fuses and connections so arranged that the reversal of the plate and re-making of the switch connections is an easy matter.

984,245. ELECTRIC-LAMP SOCKET. James E. Stewart, New York, N. Y., assignor to Annie Stewart, New York, N. Y. Filed Oct. 13, 1909. The upper and lower metallic parts are held together by V-shaped spring clips.

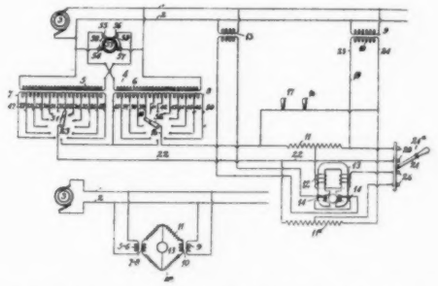
984,248. MEANS FOR STARTING VAPOR-CONVERTERS IN SERIES. Percy H. Thomas, Montclair, N. J., assignor to Cooper Hewitt Electric Co., New York, N. Y. Filed March 8, 1907. The rectifier has two main anodes, two supplemental anodes and a cathode and a suitable source, work circuit and connections in combination with a separate source of energy connected with the supplemental anodes and the cathode.



984,108.—WIRELESS DIRECTION DETECTOR.



984,119.—ELECTRIC FURNACE.



984,160.—METHOD OF TESTING TRANSFORMERS.

984,269. DYNAMO-ELECTRIC MACHINE. Hans G. Berentsen, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Co. Filed July 28, 1909. The frame of the dynamo is provided with countersunk bolt holes so that spacing bushings may be inserted.

984,286. TROLLEY ATTACHMENT. Fred J. Moeller and Frederick J. Seyerle, Pittsburg, Pa. Filed Sept. 16, 1909. The trolley-wheel harp is provided with a guard which prevents the wheel from jumping the trolley, yet allows easy removal of the wheel from the wire.

984,297. ELECTRIC METER. William H. Pratt, Lynn, Mass., assignor to General Electric Co. Filed April 20, 1904. A magnetic core forms a nearly-closed magnetic circuit having a central member and two members each are joined at one end to the central member and at the other end are separated from it by a small air-gap. A potential coil is put on the central member, a second magnetic core having poles disposed opposite to the air-gaps, and series coils on said poles.

984,301. WATCHMAN'S CLOCK. Richard C. Rose, Osceola, Ark. Filed Jan. 27, 1910. Four pairs of two electromagnets each are spaced at equal intervals around the face of the clock, contacts being made by the minute hand. A charged circuit includes the hand, one of the magnets and the contact being constantly in the path of the arm. A charged circuit includes the other magnet controlling the armature lever and a circuit-controller, being adapted to cause the rocking of the armature lever in the reverse direction to that caused by the circuit including the first magnet.

984,308. PREHEATER AND REDUCER FOR ELECTRIC SMELTING-FURNACES. Alfred Stansfield, Montreal, Quebec, Can., assignor of one-half to John W. Evans, Belleville, Can. Filed Nov. 11, 1909. A furnace receives the ore and preheats it, sending it to the electric furnace through a chute.

984,325. COMBINATION CIRCUIT-CONTROLLER. John Leo Wagner, Chicago, Ill. Filed Nov. 2, 1905. Comprises a relatively stationary frame, a conducting part carried by the frame, a rotable carrier, a movable conducting part, a concealing structure for the conducting parts, a shaft extending

through the concealing structure, and a handle upon the shaft without the structure.

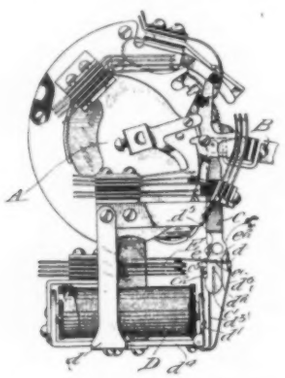
984,327. MOTOR-CONTROL APPARATUS. David Wald, Otto C. Britsch and Max Taigman, New York, N. Y. Filed April 23, 1910. A resistance has a plurality of contacts and a removable contact arm. The circuit-making member associated with the arm is operative when the arm is in engagement with each of the contacts, but inoperative when the arm is in engagement with one of the contacts.

984,368. MAGNETO-MACHINE FOR USE IN CONNECTION WITH THE IGNITION SYSTEMS OF INTERNAL-COMBUSTION ENGINES. Robert Frederick Hall, Moseley, near Birmingham, Eng. Filed Aug. 22, 1908. Combines a magneto machine and its high and low-tension circuits with a battery and coil and their high and low-tension circuits. Means are provided for mechanically connecting the contact breakers to provide for synchronic differentiated adjustment thereof, and a high-tension distributer for the high-tension circuits.

984,371. ELECTRIC FURNACE. Hubert Hoff, Düdelingen, Luxemburg, assignor to Eisenhutten-Actien-Verein Düdelingen, Düdelingen, Luxemburg. Filed Sept. 25, 1909. Combines an open hearth, a passage extending at a slant from the hearth, closing means for the passage, a conduit projecting into the passage for conveying air into the furnace, and a pipe for conveying coal dust opening into the conduit.

984,454. SPARK-PLUG FOR INTERNAL-COMBUSTION ENGINES. Robert S. Thwaite, New York, N. Y., assignor to Otto B. Shulhof, New York, N. Y. Filed March 15, 1910. The plug has a secondary spark gap exposed to view and surrounded by a transparent protecting cover, so that any cessation of sparking may be instantly detected.

984,459. SYSTEM OF ELECTRICAL DISTRIBUTION. Joseph Lester Woodbridge, Philadelphia, Pa. Filed March 20, 1908.



984,294.—PARTY-LINE LOCK-OUT.

A synchronous machine has an armature and a winding uniformly distributed over its periphery, three pairs of taps from the armature winding, each pair including a span not less than 144 and not more than 154.3 electrical degrees. The spans are successively displaced 120 electrical degrees around the periphery.

984,467. SYSTEM OF ELECTRICAL DISTRIBUTION. Joseph Bijur, New York, N. Y., assignor to the Electric Storage Battery Co., Philadelphia, Pa. Filed March 26, 1908. Combines an alternating-current circuit, a direct-current circuit, transforming apparatus connected between them, an alternating-current booster connected between the transforming apparatus and the alternating-current circuit, a suitable field coil for the transforming apparatus, another field coil for the alternating-current booster and an electro-responsive regulator adapted to control simultaneously the two field coils.

984,472. PURIFIER. Charles W. Clark, Los Angeles, Cal., assignor of one-half to Dennis A. Warner, Los Angeles, Cal. Filed Sept. 3, 1909. Includes a receptable having its top made up of a series of removable sections, a series of coils of conducting wire arranged in spaced relation within the receptacle and forming electrodes, the coils being removably secured to the sections, and electric circuit terminals connected to the coils.

984,496. CARBON-HOLDER FOR ARC-LAMPS. William N. Selig, Chicago, Ill., assignor to Selig Polyscope Co., Chicago, Ill. Original application filed April 20, 1909. Divided and this application filed Feb. 11, 1910. A V-shaped clamping block holds the carbons.

984,507. DENTAL MOTOR. William E. Butler, David City, Neb. Filed Sept. 3, 1909. The motor has permanent fields and also has means for coupling the brushes in different orders and for short-circuiting the brushes leading to the motor.

984,508. ELECTRICALLY-HEATED PRESS FOR LEATHER-WORK. Edwin N. Chandler, Brockton, Mass., assignor to Simplex Electric Heating Co., Boston, Mass. Filed June 8, 1909. Electric-heating elements are included in the top plate of the press.

984,511. ELECTRIC-MOTOR-CONTROLLING APPARATUS. Harry Ward Leonard, Bronxville, N. Y. Original application filed Jan. 23, 1905. Renewed Feb. 20, 1907. Divided and this application filed May 11, 1909. Comprises an armature-control mechanism, field-control mechanism, means normally tending to return the latter mechanism to full-field position, and a no-voltage magnet controlled by the armature-controlled mechanism for controlling the returning means.

REISSUES.

13,202. POST OR TELEGRAPH AND TELEPHONE POLE. Herbert E. Atchison, Denver, Colo., assignor to American Post & Pole Co. Filed Dec. 15, 1910. Original No. 943,134, dated Dec. 14, 1909. Consists of a bar, having angularly disposed sides and flukes projecting upwardly from its lower extremity substantially in a plane with the vertex of the angle.

13,208. APPARATUS FOR SMELTING ORES YIELDING A VOLATILE METAL. Woolsey McA. Johnson, Hartford, Conn., assignor to Continuous Zinc Furnace Co., Hartford, Conn. Filed Dec. 12, 1910. Original No. 964,268, dated July 12, 1910. An electric smelting furnace has a reducing chamber containing a carbonaceous material and having charging and discharging apertures, a condenser, and ring electrodes disposed in the reducing chamber near its opposite ends.

PATENTS THAT HAVE EXPIRED.

Following is a list of the electrical patents (issued by the United States Patent Office) that expired February 20, 1911:

514,902, 514,903 and 415,904. ALTERNATING-CURRENT MOTOR. Charles S. Bradley, Avon, N. Y.

514,907. DYNAMO-ELECTRIC MACHINE. Charles F. Brush, Cleveland, O.

514,913. CUSHION FOR TELEPHONE-RECEIVERS. Victor A. Cook, Averill Park, N. Y.

514,916. TELEPHONE. Daniel Drawbaugh, Eberly's Mill, Pa.

514,920. TELEPHONE-TRANSMITTER. Philip Fitzimons, Birmingham, Ala.

514,925. ELECTRIC CABLE. Theodore Guilleaume, Mulheim-on-the-Rhine, Germany.

514,960. ELECTRIC BELL ALARM. William H. Orpen, Jr., Brooklyn, N. Y.

514,972. ELECTRIC RAILWAY SYSTEM. Nikola Tesla, New York, N. Y.

514,973. ELECTRICAL METER. Nikola Tesla, New York, N. Y.

514,975. ELECTRICAL ANNUNCIATOR. Nelson M. Watson, Detroit, Mich.

514,979. BATTERY. David H. Wilson, Chicago, Ill.

514,980. SWITCHBOARD SYSTEM. David H. Wilson, Chicago, Ill.

514,981. CIRCUIT MAKING AND BREAKING DEVICE. David H. Wilson, Chicago, Ill.

515,020. ELECTRICAL CONVERTER. Andrew L. Riker, New York, N. Y.

515,022. ELECTRIC ARC LAMP. Samuel W. Rushmore, Brooklyn, N. Y.

515,087. ELECTRIC DISTRIBUTION BOX. Oscar D. Kleinsteuber and Monroe A. Kleinsteuber, Milwaukee, Wis.

515,108 and 515,109. ELECTRICAL CIRCUIT CONTROLLER. Romaine Callender, Brantford, Canada.

515,110. AUTOMATIC SIGNALING TRANSMITTER. Romaine Callender, Brantford, Canada.

515,125. ARC LAMP. William C. Meissner, Chicago, Ill.

515,145. ELECTRIC SIGNALING BETWEEN RAILWAY TRAINS. Julius J. Czepull, Lancaster, Pa.

515,170. AUTOMATIC TOLL-BOX FOR TELEPHONE PAY-STATIONS. Howard C. Root, Brooklyn, N. Y.

515,179. ELECTRIC-RAILWAY CONDUIT. Morris S. Towson, Cleveland, O.

515,189. ELECTRIC TIME-ALARM. John C. Betts, Philadelphia, Pa.

515,192. MATERIAL FOR INSULATING ELECTRIC WIRES. Gustave A. Cannot, London, England.

515,205. ELECRIC ARC LAMP. Bruce Ford, Johnstown, Pa.

515,216. DYNAMO OR ELECTRIC MOTOR. Ludwig Gutmann, Pittsburg, Pa.

515,241. RHEOSTAT. John B. Lyon, Brooklyn, N. Y.

515,254. RHEOSTAT. Alton J. Shaw, Muskegon, Mich.

515,255 and 515,256. ELECTRIC ELEVATOR BRAKE. Alton H. Shaw, Muskegon, Mich.

515,274. INDICATOR FOR ELECTRIC CARS. Henry C. Beckmann, St. Louis, Mo.

515,280. RHEOSTAT. George A. Brown, Muskegon, Mich.

515,281. ELECTRIC ELEVATOR BRAKE. George A. Brown, Muskegan, Mich.

515,286. ELECTRIC STEERING GEAR. Frank L. Dyer, Washington, D. C.

515,297. ELECTRIC IGNITER FOR GAS-ENGINES. Joshua Law and James W. Gow, Steubenville, O.

515,304. RHEOSTAT. Alton J. Shaw, Muskegon, Mich.

515,308. ELECTRIC-RAILWAY TROLLEY. Charles J. Van Depoele, Lynn, Mass.; C. A. Coffin and Albert Wahl, administrators.